Centre for
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Queen's University
Kingston, Ontario

Federal and Provincial Taxation of the Canadian Mining Industry: Impact and Implications for Reform

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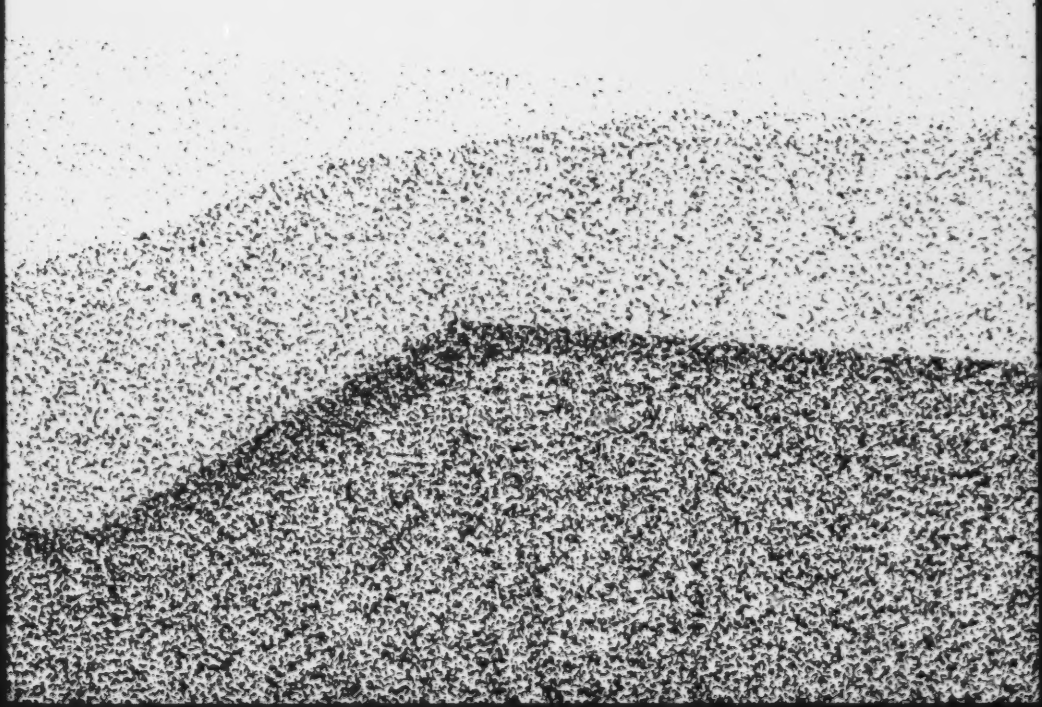

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August 1989

89-06061/

Canadian Cataloguing in Publication Data

Boadway, Robin W., 1943-

Federal and provincial taxation of the Canadian mining industry

(Monograph ; 24)
Bibliography: p.
Includes index.
ISBN 0-88757-097-6

Mineral industries - Taxation - Canada. 2. Mines and mineral resources - Taxation - Canada. I. McKenzie, Kenneth J. (Kenneth James), 1959- . II. Mintz, Jack M. III. Queen's University (Kingston, Ont.). Centre for Resource Studies. IV. Title. V. Series: Monographs (Queen's University (Kingston, Ont.). Centre for Resource Studies) ; 24.

HD9506.C22B6 336.2'78622'0971 C89-094678-7

Laser typeset by *Academic Horizons*, Kingston, Ontario

Foreword

The taxation of natural resources extraction industries has a major influence on their economic viability, on the efficiency of allocation of capital, and the net benefits to society generated by the existence of the resources. This study examines federal and provincial taxation of the mining industry in Canada, and finds strong evidence of inefficiencies in the existing tax regimes. Measures for reform now being proposed offer little improvement. The authors propose alternative approaches to tax reform designed to better satisfy government revenue requirements, while reducing inequities and inefficiencies.

The Centre for Resource Studies is pleased to present this study, which represents a major contribution in an important area little studied by academic economists. The views expressed are those of the authors, and do not necessarily represent the views of the Centre or its sponsors.

Margot J. Wojciechowski
Centre for Resource Studies

Acknowledgements

We are grateful to the Centre for Resource Studies for the opportunity to conduct this study of the effects of tax policy on the mining industry and mining tax reform. The work we have done is an extension of some earlier work conducted with Neil Bruce of Queen's University. We owe a considerable debt to him for jointly developing the ideas underlying the effective tax rate methodology as well as the policy implications for the industry. We are also grateful to the federal Department of Finance for the use of taxation data pertaining to the mining industry and the Government of Saskatchewan for information relevant to potash and uranium industries. A preliminary version of some of the results was presented to the Centre for Resource Studies seminar on taxation, and we thank participants for helpful early feedback.

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Summary

The study of the tax treatment of the mining industry and of the design of appropriate tax policies is of considerable importance for Canada given the special role that this industry plays in the economy. Yet, it is also one that has been sadly neglected by economists. Part of this has to do with the fact that mining taxes tend to be levied by the provinces, while much of the tax reform impetus in recent years has been at the federal level. Another part reflects the fact that academic economists have tended to be preoccupied with more general issues of income and sales tax reform. This is unfortunate both because there are important policy issues involved in the taxation of this important sector, and also because attempting to evaluate the system of income and sales taxation while neglecting the concurrent effects of mining taxation can give, we believe, misleading policy prescriptions.

The study attempts to do two broad things. First, we investigate how the existing system of income taxation and provincial mining taxation impinge upon the incentives to invest in mining at all stages from initial exploration to final depletion and sale. To do this, we use the concept of an effective tax rate which is an extremely useful summary measure of the full effects that the tax system has on incentives. The results we obtain are quite illuminating. They show, above all, that, given what one thinks is the probable intent of mining taxation, viz., to capture some of the value of resources for the public sector (particularly the provincial public sectors), the tax system has a number of highly discriminatory and capricious side effects which render it inappropriate for the stated purpose. What is particularly discouraging is that it seems to discriminate systematically against small growing firms and firms in a loss position, and in favour of large established firms. The effect is a disincentive for young dynamic firms to develop. In addition, the system is very fragmented, with different types of decisions in different sectors of the industry in different provinces facing different tax treatment. This lack of harmonization is itself a source of inefficiency.

The current system of tax reforms being initiated by the federal government does little to address these issues. What we have attempted to do as our second task is to investigate what sort of reforms would improve the system. The reforms we have in mind are those which would satisfy government revenue requirements while at the same time removing the adverse effects of the existing system on the industry. We hope, if nothing else, to provoke policy debate on the issues.

Résumé

L'étude concernant le traitement des taxes sur l'industrie minière et la détermination d'un modèle de politiques gouvernant l'imposition de taxes appropriées est d'importance considérable pour l'économie canadienne à cause du rôle spécial de cette industrie. Mais en plus, c'est un rôle qui a été déplorablement négligé par les economistes. Une partie de ceci peut sans doute être expliquée par le fait que les taxes minières sont imposées par les provinces, tandis que, durant les dernières années, la plupart des propositions réformistes est venue du niveau fédéral. Une autre partie reflète le fait que les économistes académiques sont sujets à être préoccupés des questions plus générales comme la réforme des impôts sur revenu et la taxe de ventes. C'est une situation regrettable parce qu'il y a d'importantes questions de politiques impliquées dans l'imposition de taxes sur ce secteur, et parce qu'en essayant d'évaluer le système d'impôts et la taxe de ventes tout en négligeant les effets concurrants des taxes minières peuvent résulter, nous croyons, dans l'imposition de prescriptions politiques trompeuses.

L'étude a deux buts généraux. Premièrement, nous examinons comment le système présent d'impôts sur revenus et de taxe minière provinciale empiète sur les stimulants d'investissement dans l'industrie minière à tous les étapes, de l'exploration préliminaire jusqu'a l'épuisement et la vente. Pour accomplir ceci, nous utilisons le concept d'un taux efficace de taxes qui est une mesure sommaire extrèmement utile des effets complets que le système de taxes cause sur les stimulants d'investissement. Les résultats obtenus sont tout à fait élucidants. Ils démontrent surtout, que, si l'on accepte pour donné que l'intention probable des taxes minières est la capture d'une partie de la valeur des ressources pour le secteur publique (particulièrement les secteurs publiques provinciaux), le système a de nombreaux effets secondaires discriminatoires et capricieux qui le rend peu approprié pour accomplir le but enoncé. Ce qui est particulièrement décourageant est que le système semble discriminer systématiquement envers les petites entreprises croissantes, celles qui sont en position de perte, tout en favorisant les grandes entreprises établies. L'effet est de décourager le développement des jeunes entreprises dynamiques. En plus, le système est tellement fragmenté que différents types de décisions dans différents secteurs de l'industrie dans différentes provinces font face à des traitements de taxes différentes. Ce manque d'harmonization est lui-même une source d'inefficacité. Le système présent pour la réforme des taxes initié par le gouvernement fédéral n'addresse pas ces questions de façon satisfaisante.

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1. Introduction

ECONOMIC RENTS

The tax system can affect the business decisions of mining firms in a number of ways. Decisions regarding investments in structures, machinery, inventories, and exploration and development, the rate at which to extract the depletable resource, the level of risk taking to engage in, the financing of capital, and even the location of the mine and processing facilities, can all be influenced, to varying degrees, by the tax system. This study is concerned with examining and evaluating the incentive effects of the Canadian income and mining tax systems on these decisions.

Economists have long utilized the concept of economic "rents" in evaluating tax policy, especially in relation to nonrenewable resource industries. They expound upon the merits of rent taxation, focusing primarily upon the fact that a pure rent tax does not distort investment decisions and therefore is able to collect revenues in a manner so as not to affect the market decisions of producers. Economic rent is defined as the return paid to factors that are fixed in supply, and can be measured as the difference between gross revenues and all of the imputed costs of producing the resource. Taxing these rents in no way impinges upon investment and expenditure decisions.

Any analysis of the taxation of mining and other nonrenewable resource industries necessarily involves a discussion of rents, either implicitly or explicitly. This need arises because, unlike most other industries, one of the major inputs used in production, namely the nonrenewable resource itself, is ultimately fixed in supply. Therefore, the return on the resource, after accounting for all costs of production, is of the nature of a rent. A major challenge for tax policy is to identify and extract some share of this rent for the public sector. The tax policy instruments for achieving this are a matter for economic analysis. However, the appropriate sharing of rents between the public and private sectors is an issue which extends beyond economics. Fortunately, the choice of tax instruments can be made independently of the judgement that must be made about the property rights to resource rents.

A further issue of particular importance to Canadian mining tax policy concerns the division of the public sector's share of rents between federal and provincial governments. Again, property rights are not clearly enunciated here, and economic analysis can offer little to settle disputes which may arise in this regard. The provinces may claim ownership of the resources by virtue of Section 92 of the Canadian Constitution. The usual method used by the provinces to exercise their rights in this regard has been to levy separate taxes or royalties on resource firms which operate in the province. The claim of the

federal government is perhaps somewhat more contentious, and is derived from its general and unlimited taxing power granted under the Constitution. As we shall discuss further in chapter 4, one predominant interpretation of the corporate income tax has been as a device for collecting rents from the resource and other sectors.

In principle, a rent tax could be levied in an efficient manner, ensuring that the resources are exploited without the tax interfering with the decisions made by mining firms. Since market prices act as signals for resources to be allocated properly in the economy, a rent tax allows governments to maximize the amount of tax revenue collected from the industry without imposing other costs on the economy associated with the misallocation of resources. This is because a properly imposed rent tax will not interfere with the prices and costs faced by resource firms. Thus a rent tax is "neutral" in the sense that it does not affect the investment, risk-taking, or financing decisions made by mining firms. A properly conceived rent tax will still collect substantial revenue, since revenues from the sale of resources are greater than the economic cost of exploration, development and extraction (correctly measured).

We have argued that a major objective in taxing resource firms is the collection of a portion of rents (most certainly by the provinces and perhaps less so on the part of the federal government). This is not to say that this is the only reason governments may have for taxing mining firms. Aside from the obvious role of revenue collection, taxation has traditionally served other purposes as well (rightly or wrongly). In the case of mining, regional development comes immediately to mind. Taxation can also be used as a part of an overall industrial stategy designed to encourage certain types of activity. Also, if it is perceived that market prices are not sending the "correct" signals to market participants then taxation can be used as a remedial device. It is often argued, for example, that generous tax measures are required to compensate resource firms for the inherent "riskiness" of their activities. In fact, as should become apparent in chapters 3 and 4, this argument is tenable only if risk is not being priced correctly by the market.

Whatever the objective of tax policy, we feel that it is extremely important to measure any gains perceived to be associated with the policy against the distortions created in the market place due to a deviation from a pure rent tax. A main objective of this study is to determine how closely the current federal and provincial tax regimes conform to a rent tax on mining firms. To the extent that taxes deviate from the "ideal" of rent taxation, investment and operating decisions are distorted. If one believes that undistorted market signals are the most efficient way of allocating resources in a capitalist economy, then the distortions arising from non-neutral taxation impose real costs on the economy which should be taken into account in evaluating government tax policy.

MARGINAL EFFECTIVE TAX RATE

To accomplish our objective of measuring the extent to which the taxation of mining in Canada may distort investment decisions, we assess the incentive effect of the taxes on the *marginal investment decisions* of mining firms. The marginal investment decision is important because it is presumed that firms invest in inputs for production up to the point at which the income generated from the last increment of investment (i.e., the marginal increment) is just equal to the cost. If this were not the case, then the firm could increase its profits by either increasing or decreasing investment appropriately. The last, or marginal, unit of investment thus "breaks even" in an economic sense, and generates no rent; if a tax is based solely on rents, then the tax rate on the income generated by the marginal investment is thus zero. In this case the tax system is nondistorting, since the level of investment is not affected by the tax; the income generated from the marginal investment pays no tax; therefore, the level of investment is unchanged by the tax. Again, it should be stressed that this is not to say that no revenue is collected from the tax, as inframarginal investments clearly earn rents which are subject to taxation. If tax is collected on the "break-even", or marginal, increment of investment, then the "effective" rate of tax on the marginal investment is not zero and the tax is distortionary.

The *marginal effective tax rate* can thus be thought of quite simply as the tax owing on the income generated by the marginal expenditure. We can measure marginal effective tax rates for each type of investment and expenditure decision undertaken by mining firms and can therefore determine the extent to which the tax system distorts each of these decisions. If the marginal effective tax rate on a given type of expenditure is positive, then the tax system provides a disincentive to invest in that type of capital. As we explain in the chapters that follow, it is quite possible for the tax rate on income generated by the marginal investment to be negative. This means that the tax system subsidizes that type of investment, and investment is encouraged by the tax system.

In this study we concentrate upon the impact of the federal and provincial corporate income tax and of the numerous provincial mining tax regimes. We provide estimates of marginal effective tax rates for the following investments undertaken by mining firms:

- physical mining and processing assets;
- depletable assets;
- exploration and development;
- inventories.

We also assess the impact of taxation on risk-taking, and upon financing decisions, particularly as the latter relates to the use of flow-through shares.

Previous studies have often calculated so-called *average effective tax rates*, rather than the marginal effective tax rates which we measure in this

monograph. The average tax rate is measured simply as total taxes divided by the (appropriately defined) profit earned by the firm. Although the average tax rate provides a clear indication of the burden of taxes imposed on the firm, it provides incorrect information regarding the incentive effect of taxes, since the average tax rate uses taxes and income generated by both inframarginal and marginal investments (this is discussed in detail in chapter 3). It is thus quite possible for the average tax rate to differ substantially from the marginal one. For example, as discussed above, with a pure rent tax, taxes are collected on the income generated by inframarginal investments but not on the marginal investment; the average effective tax rate is thus positive while the marginal effective rate is zero (as a pure rent tax is non-distorting). If the average tax rate is used to determine the impact of taxes on investment decisions, one would erroneously conclude that the rent tax deters investment even though the marginal decision is not affected by the rent tax.

Although marginal effective tax rates are conceptually better to use for analyzing the incentive effect of taxes, we will point out later some of the difficulties involved in their estimation. These difficulties are related to the assumptions, methodology and data used in the analysis. The incorporation of risk into the analysis and the modelling of the exploration and development process are also important issues. One very important problem is the measurement of effective tax rates for firms that do not pay taxes at all times due to losses and unused deductions. Although theoretically we can measure marginal effective tax rates under these circumstances, the complete data needed for the analysis of investments made by tax loss firms are extensive and not available to us. Our analysis of the marginal tax distortion imposed on loss firms is thus based on illustrative hypothetical examples. The reader is therefore cautioned that the effective tax rate measures we report for these types of firms are only *indicative* of the incentive effects of the taxes; an accurate quantification of the incentive effect of taxes cannot be done without resolving the problems we discuss later. Nevertheless, we feel that the figures we compute are very suggestive of the incentive effects of the current tax system.

ORGANIZATION OF THE STUDY

The outline of the monograph is as follows. Chapter 2 reviews the federal and provincial corporate income tax (as it applies to mining) and various provincial mining tax regimes. This review includes a discussion of the recent federal income tax reform measures. In chapter 3 we describe the concept of marginal effective tax rates in more detail and present the effective tax rate measures for mining investments by type of capital and province and for various special cases, including tax loss companies. This includes an assessment of the impact of the tax reform proposals on the mining industry. Chapter 4 concludes the monograph with a summary and our own policy recommendations for mining

tax reform. We also include two rather extensive appendices discussing in more depth the theoretical and empirical methodology we use in the study. This was done so that we could confine our discussion in the main text to the important issues without distracting the reader with unnecessary mathematical formalism. The discussion in the main text is thus heuristic and intuitive. The theoretical methodology underlying the marginal effective tax rate estimates is presented in appendix A. We begin the appendix with a conceptual explanation of marginal effective tax rates which involves slightly more formalism than is contained in the main text; this is followed by a more mathematical treatment for those that are inclined towards somewhat more rigour. In this way we hope to present the methodology to as broad an audience as possible. Appendix B contains a description of the data used in our estimates.

SUMMARY OF FINDINGS

Our analysis of effective tax rates suggests that there is room for considerable improvement in the rent-collecting objective of the tax system as it relates to mining. We find that on the whole the corporate and mining tax regimes in Canada provide a substantial subsidy to investments in the mining industry, particularly for profitable and well established companies that are in a position to make full use of generous tax write-offs. Marginal effective tax rates are highly negative for many of the major expenditures undertaken by these mining firms: exploration and development, processing, and investments in new mines or substantial mine expansions are all encouraged by the tax system. At the same time, firms in a tax loss position are not able to take full advantage of these marginal subsidies since many of them take the form of rapid write-offs against taxable income (which is zero for loss firms). For these firms, many of which are reputed to be small, growing companies engaged in "risky" activities, the tax system tends to act as a drag. These firms cannot use fast write-offs until they earn sufficient taxable income. The value of the write-offs is thus eroded over time since losses are not carried forward at the rate of interest for tax purposes. Relative to large taxpaying firms which can use these fast write-offs immediately, small growing companies are placed at a disadvantage since they cannot make full use of subsidies offered through the tax system. While flow-through shares are designed to deal at least partly with this problem, the mechanism is an ineffective way of allowing non-taxpaying corporations to take advantage of tax write-offs (this is discussed in more detail below).

There are also substantial inter-asset distortions within the mining industry caused by the tax system. These arise from large variations in the marginal effective tax rates on different types of capital used in the mining sector. As indicated above, many expenditures are encouraged by the tax system; others, such as investment in inventories, face positive tax rates on marginal investments. To the extent that different assets are substitutable in the production

process, the wide variation in effective tax rates across assets implies that the tax system distorts the production and investment choices by mining firms. We also find that marginal effective tax rates vary considerably across provinces. To the extent that mining companies are in a position to choose in which province they will locate their facilities, this implies that this location decision is also influenced by the Canadian tax system. In analyzing the impact of federal tax reform proposals on the various distortions discussed above, we find that the reforms moderate the distortions slightly but do little to correct the apparently significant misallocation of resources associated with the taxation of mining in Canada.

In light of the considerable distorting effects of the current tax system, in the concluding chapter (chapter 4) we discuss ways in which the taxation of mining in Canada might be further reformed. We recommend three general policy changes in this regard. The first is to **reform provincial mining tax regimes by instituting a form of a cash flow taxation as a substitute for the current taxes on mining profits.** It is often argued that pure rent taxes are difficult to apply in practice because rents are not easily measured; this is not true. A cash flow tax, which taxes the difference between revenues and all costs (current and capital) immediately on a cash basis is neutral. By expensing capital immediately and not allowing financing deductions for interest (as opposed to allowing interest deductibility and depreciation), all of the costs of producing income are correctly imputed, and the cash flow tax acts as a simple and effective rent tax. Indeed the simplicity of the cash flow tax adds to its appeal, as it is straightforward to apply and does not require firms to keep track of tax depreciation bases, etc., as is required under current mining tax regimes. As we discuss in chapter 4, there are numerous tax bases which are equivalent to the cash flow tax in present value terms, and are thus nondistorting.

The second reform we suggest is to **allow for the refundability of tax losses so that the start-up investments of junior mining firms are treated on the same basis as large taxpaying companies that are able to fully use their tax deductions.** This full refundability, or full loss offset, is vital for the correct operation of the cash flow tax recommended above as a replacement for current provincial mining taxes. It helps ensure that taxation does not discourage risktaking, and can act as a valuable source of financing to the firm. For similar reasons, we would also encourage the introduction of full refundability at the corporate tax level. We do not believe the current reliance on "flow-through shares" is a good method of conveying tax benefits to non-taxpaying companies. The mechanism is costly to operate and does not ensure that the firm gets the full value of the corporate write-off. Full refundability, where firms receive a refundable tax credit equal to the amount of the loss times the tax rate, is much more effective and simple to operate and monitor. While we applaud some of the provisions in the recent tax reform proposals, particularly the elimination of earned depletion, we feel that a move to full refundability would do much to

address the current inefficiencies associated with the taxation of mining in Canada, particularly as they relate to small growing firms.

Our third recommendation is for **harmonization of provincial mining tax regimes**. While there is an attempt by federal and provincial governments to harmonize the corporate income tax base, there has been no attempt to do the same for provincial mining tax regimes. As a result of this lack of coordination, the resource tax system is extremely complicated for the private sector to comply with, as provincial tax regimes differ widely. There also appears to be a tendency for provinces to in effect bid against each other for mining investments by putting in place tax incentives to attract capital. Such "beggar-thy-neighbor" policies lead to substantial subsidies paid to mining activities (such as processing) without necessarily leading to significant new activity, since all provinces tend to engage in this form of "tax competition". If provincial governments harmonized their tax regimes, they could avoid the competition that leads to an erosion of their rent tax bases. The uniform adoption of the cash flow approach suggested above would address this problem, which further adds to its appeal.

2. Description of Corporation Income and Mining Taxes

In this chapter the features of the tax system that are most important for the mining industry are discussed. The discussion is non-technical, intended primarily to give a broad overview of the taxation of mining income in Canada and to provide a background for the analysis that is presented in later chapters. As such, the discussion is largely descriptive, focusing upon the institutional characteristics of the tax system rather than its economic impacts. Income earned by Canadian mining companies is generally subject to three levels of taxation: federal income taxes; provincial income taxes; and provincial mining taxes, royalties, or other similar levies. This study focuses exclusively upon these three levels of taxation. Sales taxes on business inputs, property taxes, mineral rights fees, gasoline and fuel oil taxes, water taxes, provincial capital taxes, etc. will not be discussed. Although income taxation is considered in the context of corporations, similar provisions apply for unincorporated businesses.

The chapter begins with a brief discussion of different notions of income which are important in this study, and a description of the relevant stages in the mining process for tax purposes. Next, the pre-tax-reform (1985) rules for determining the federal corporate income tax are examined, followed by a description of the provincial income tax rules. The chapter continues with a discussion of the federal corporate tax reform changes and proposals made since 1985. Two phases of the recent process of federal corporate tax reform are discussed: the revisions made in the 1986 Budget; and the proposals contained in the 1987 White Paper on Income Tax Reform. The chapter concludes with a description of various provincial mining tax laws.

THE CORPORATE INCOME TAX

Before commencing with the description of the corporate income tax system, it is important to distinguish between three notions of "income" which should be kept in mind throughout the discussion: book income, taxable income, and economic income. Book income is the income reported on the firm's financial statements. The general approach in the calculation of book income consists of subtracting, from accrued gross revenues, accrued operating costs and certain deductions for capital expenditures (such as interest and depreciation) computed in accordance with generally accepted accounting principles.

Generally speaking, the taxable income of a taxpayer is computed by taking the net book income reported by the corporation and modifying it according to the specific provisions of the Canadian Income Tax Act. These modifications

usually take the form of timing adjustments, as some expenditures are written off at different rates and over different periods for accounting purposes than for tax purposes. For example, expenditures on depreciable property are written off for tax purposes at prescribed rates (the Capital Cost Allowance, or CCA rates) that typically differ from the rates used for book purposes. Some of the most important areas where taxable income differs from book income are:

- exploration and development expenditures and the acquisition of property rights;
- depletion allowances;
- capital cost allowances;
- resource allowances.

Economists have a somewhat different view of business income, referred to as the economic income of the firm, also called its pure profits or rents. This concept will be made clearer in later chapters when the economic impact of the tax system upon the investment decisions of mining companies is discussed in more detail. However, it is useful to introduce the concept at this point so that it may be kept in mind throughout the institutional discussion that follows. In principle, the idea is relatively simple: economic income is merely the difference between the accrued revenues of the firm and the imputed costs of producing that revenue, the latter including the opportunity cost of the firm's factors of production (the minimum amount they would have to be paid to keep them in their current use, or, equivalently, the maximum amount they could earn in an alternative use). Any tax levied upon the pure economic profits of a firm has no impact upon the firm's investment or production decisions. Since economic income consists of income earned over and above that which is required to keep all factors and resources employed in their present use, taxing these profits does not affect the firm's economic decisions.

There are many ways to impose a tax on economic profits. One potential approach is to define a *pure profits tax base* which allows for the deduction of the true opportunity cost of all inputs used in the production of the output. Revenues should include all sales and capital gains as they accrue, rather than as they are realized. For current expenditures, such as those on labour and materials, the opportunity cost is simply the actual market cost of these items, deducted on an accrual (accounts payable) basis. In the case of physical capital expenditures, the imputed or opportunity cost includes the true economic depreciation of the asset (due to wear and tear, obsolescence, and any accrued capital gain, adjusted for inflation, on holding the asset) evaluated at its current replacement cost (rather than its historical or original cost). Also included as an imputed cost of capital are the financing costs, which should be adjusted for inflation. This is the real cost of finance, which is approximately a weighted average of the nominal cost of debt and equity finance less the expected rate of

inflation. Thus, the total economic cost of a unit of depreciable capital is the rate of economic depreciation plus the real cost of finance.

The cost of holding land is the real cost of (debt and equity) financing less any accrued capital gains adjusted for inflation. The cost of holding a depletable resource is the opportunity cost of extracting and selling the ore and investing the proceeds in a monetary asset (or, equivalently, buying back liabilities). This is equal to the real cost of finance less the fall in the value of total reserves due to extraction. Similar costs can be defined for inventory capital, financial assets, etc.

Another method of taxing economic income is the *cash flow* approach. In this case, the tax is applied to a base which allows all capital costs to be deducted immediately, as they accrue, in lieu of the depreciation and financing deductions required in the economic profits approach. If the appropriate deductions are made, the pure profits and cash flow tax bases are equivalent in present-value terms. In fact there are a large number of tax bases which are equivalent to the cash flow and economic profit tax bases in present-value terms. Any tax base which has the property that the present value of the tax deductions equals the initial expenditure on the input is equivalent to a cash flow base. Tax bases which have this property are relatively easy to administer, as will be discussed in chapter 4.

To tax economic income, all of the approaches must have the equivalent of full loss offset. A full loss offset requires that all current losses be either refunded (at the business tax rate) by the government, or carried forward at the appropriate rate of interest (i.e., the weighted average cost of funds) for future deduction. If the firm winds up, any credits owing to the firm must be paid at that time. If full loss offsetting is permitted, firms are essentially able to deduct the cost of risk as the government shares equally in the losses and profits of the firm. This will be discussed in more detail in chapter 3.

These concepts will be made clearer later on but at least two points should be noted here. First, economic income recognizes all of the explicit and the implicit costs of using resources to produce output, including the income foregone by utilizing resources for the activity in question rather than for some other activity, and any changes in the real value of the resource. Second, taxing economic income has no impact upon the investment, production, or any other resource allocation decisions of firms — a tax on economic income is "neutral".

Tax reform in Canada is an ongoing process. The dynamic nature of the federal tax regime has been particularly evident over the past two years. In a discussion paper released with the May 1985 Budget, *The Corporate Tax System: A Direction for Change*, the Department of Finance outlined a general approach to the reform of the corporate tax system. In the February 1986 Budget some of the changes discussed in the 1985 paper were implemented as "Phase One" of a more comprehensive tax reform. On June 18, 1987, in a White Paper outlining proposed changes to the personal, corporate and sales tax regimes,

the Department revealed its remaining agenda for the most sweeping reform of the Canadian tax system since the tax reform of 1971.

The rapid changes that are currently underway in Canadian tax law make it difficult to undertake an analysis of the system without becoming entangled in a description of the many modifications. In order to provide a stable point of reference and to allow the discussion to proceed in an orderly manner, the system which was in place at the end of 1985 will be designated as the *pre*-reform *regime* and will be described first. The *post*-reform *system* will include the reforms made in the 1986 Budget and the modifications contained in the 1987 Tax Reform proposals. In adopting this distinction between the pre- and post-reform systems we are not only able to organize the discussion in a more orderly fashion, but are able to present the important tax reform changes that have occurred (and have been proposed) over the past two years as a complete package at the end of this section.[1]

When describing the taxation of mining income in Canada, it is useful to distinguish among five stages in the mining operation. Indeed, these distinctions can be very important in determining the manner in which a revenue or expense item is treated for tax purposes. The first stage involves grassroots exploration. This involves the actual search for and discovery of the ore and an evaluation of its grade and characteristics. The second stage is the development or pre-production stage. In this phase, the mine infrastructure is established for subsequent production. The third stage is the true mining or extraction stage, which involves the actual removal of the mineral ore from the ground. The fourth stage is the milling or processing of the raw ore up to the prime metal stage. This typically involves concentrating, smelting and refining.[2] In the final stage, the ore is processed beyond the prime metal stage; this involves fabrication and semi-fabrication. These stages may be performed by a single integrated unit or by various unrelated firms.

The first four stages comprise what is referred to as mining operations and the income generated therefrom as resource income. The last stage is

1 As this monograph was in its final editing stage, the Tax Reform legislation was tabled in the House of Commons. Although the proposals introduced in 1987 were substantially unchanged, a few provisions which are of interest to the mining sector were altered. Time considerations prevent the incorporation of all of these changes in the analysis; however, important changes regarding the use of flow-through-share financing will be discussed. An attempt will be made to identify other relevant changes by footnote at appropriate points.

2 Concentration refers to any treatment of ore or tailings to separate mineral substances from its gangue (valueless earth or soil in which the ore is found) to obtain concentrate. Smelting refers to any treatment of an ore or concentrate where the charge is melted and chemically converted to produce a slag and a matte or metal in the metallic state containing impurities. Refining refers to any treatment of a smelter product of concentrate to remove impurities, producing a very high-grade metal in metallic state.

considered a manufacturing and processing activity for tax purposes. Taxpayers are required to differentiate between income and expenditures related to mining activities, and income and expenditures related to other activities. This "sourcing" of income and expenditures is necessary as the taxpayer is permitted certain allowances and deductions based upon resource activities only. Income related to activities carried out beyond the first four stages, i.e., which involves processing beyond the prime metal stage, is not considered resource income for tax purposes and is subject instead to a different set of rules which apply to manufacturing and processing income.

It should also be noted that the description of the tax system which follows relates primarily to the taxation of income from mining operations, which may be distinguished from petroleum and natural gas activities. Although at the federal corporate tax level the taxation of oil and gas companies conforms in many respects to the treatment afforded mining firms, no attempt will be made here to highlight the similarities and differences. There is one important exception to this rule, however. The Income Tax Act defines a "Mineral Resource" as a deposit of base or precious metals, coal, oil sands or shale, industrial minerals, sylvite, halite or gypsum, and sandstone or quartzite. Income from bituminous oil sand and oil shale deposits is thus considered mining income for federal income tax purposes. The description of the federal tax system that follows thus applies to traditional mining activities as well as oil sand operations.

THE FEDERAL CORPORATE INCOME TAX SYSTEM

The basic provisions of the federal income tax apply to all sectors of the economy. Only the most important of these provisions and those special to the mining industry are examined here. We focus primarily upon the rules as they relate to an incorporated domestic Canadian corporation.

Nevertheless, most of the provisions (with the exception of tax rates) are the same for unincorporated business. Moreover, foreign-owned subsidiaries financing their investments through retained earnings will be subject to the same set of rules on their non-patriated income.[3] Finally, the reader is reminded that the following discussion relates to the pre-reform (pre-1986) corporate tax system; the post-reform regime will be discussed in a separate section to follow.

The calculation of federal income tax payable proceeds as follows. Taxable income is determined by deducting from gross revenues various costs incurred in the earning of income. A tax rate is then applied to the taxable income base to determine the basic federal tax liability. This liability may then be directly

3 We do not discuss the treatment of foreign source income or the arrangement under which foreign firms operate in Canada. For a general discussion of the latter, see Bruce (1988).

reduced by various credits the taxpayer has earned in accordance with the rules of the Income Tax Act.

Gross Revenue

The gross revenue of the corporation for tax purposes consists of the accrued value of all of its sales during the taxation year. This means that revenue is recognized when a sale is transacted rather than when payment is actually received. The difference between accrued revenues and cash receipts is placed in accounts receivable. Note that the carrying forward of accounts receivable gives rise to a financing cost. This recognition of revenues on an accrual basis rather than a realization or cash flow basis by and large conforms to the definitions of both financial and economic income given above.

Deductions From Gross Revenue

Firms are permitted to deduct from gross revenues a number of costs incurred in the process of earning income. In general, to be deductible an expenditure must be considered "reasonable" given the circumstances and incurred for the purpose of gaining or producing income from property or a business. Like revenues, expenditures are generally recognized as they accrue rather than when they are realized, the difference being placed in accounts payable by the firm.

Expenditures are usually classified as either current or capital in nature. Current expenses are typically recurring costs incurred to produce current income. For tax purposes, current expenses are usually fully deductible as they accrue. Capital expenditures are costs incurred to create or acquire an asset of enduring value that gives rise to an income stream over time. Capital costs are either written off for tax purposes as they accrue or deducted over time, depending upon the type of capital in question.

Current Expenses

Current expenses are fully deductible as they accrue (rather than when they are actually paid). They consist of the current (operating) costs of recovering ore from the mine after the commencement of commercial production, and processing costs incurred prior to the prime metal stage. They include items such as the cost of labour, fuel, repairs, insurance, raw materials, transportation, etc.

Exploration and Development Expenditures

In general, all costs incurred by the taxpayer in exploring for and developing mineral deposits up to the point of commercial production are immediately deductible against current income, whether or not those specific exploration and development expenditures produce income in the year, or lead directly to the discovery or development of a mineral deposit.

A central feature of the Canadian tax system, one that is particularly important for resource industries, is the concept of tax pools. Expenditures are accumulated in a variety of accounts or pools and written off at specified rates. Exploration and development expenditures are deducted on this basis. Since 1974 these expenditures have been placed in separate pools and classified as either a Canadian Exploration Expense (CEE) or Canadian Development Expense (CDE). All expenditures incurred up to the end of the year are accumulated in pools called Cumulative Canadian Exploration Expense (CCEE) and Cumulative Canadian Development Expense (CCDE). These cumulative pools are then reduced by CEE and CDE claimed in the taxation year. The write-off rate for CEE is 100 per cent, while CDE may be written off on a 30 per cent declining balance basis (see below).

Canadian Exploration Expense (CEE)

Canadian exploration expenses include the following:

i) expenses incurred to determine the existence, location, extent or quality of a mineral resource in Canada in the course of:

- prospecting;
- carrying out geological, geophysical or geochemical surveys;
- drilling by rotary, diamond, percussion or other methods;
- trenching, digging rest pits and preliminary sampling.

ii) expenses incurred prior to the start of commercial production to bring a mineral resource in Canada into commercial production including expenses incurred in:

- clearing, removing overburden and stripping;
- sinking mine shafts, constructing an adit or other underground entry.

It is evident that the Income Tax Act includes two distinct types of "exploration" in CEE. The first, described in point i), is known as grassroots exploration. This involves activities that are traditionally viewed as exploration prospecting, geological surveys, drilling for ore samples, etc. The second type of CEE, point ii) above, includes pre-production expenditures, or "development-type" CEE. These include expenses associated with activities that take place prior to the commencement of commercial production from the mine, and include the sinking of mine shafts and other types of underground excavation and workings. These same expenditures incurred after the commencement of commercial production are not included in CEE, and receive different treatment depending upon the type of expense in question. Expenses incurred in the sinking of a post-production mine shaft, for example, are included in Capital Cost Allowances (CCA) class 12 (see below). Other types of expenditures may be placed in other CCA classes or treated as an operating cost. Even if the post-production expenses are written off immediately (as either a class 12

expense, an operating cost, or CEE), the distinction can be important because, as will be seen below, CCA and operating expenses reduce the resource allowance while CEE does not.[4]

The Income Tax Act provides no guidance in the determination of when commercial production commences. A common rule of thumb is the first day following the first three-month period over which the mine (including the mill) operates consistently at 60 percent of its rated capacity. This rule is open to interpretation, and is readily abandoned in favour of alternative approaches when deemed appropriate by the tax authorities.

The CEE write-off rate is 100 percent. The taxpayer may deduct unclaimed CEE (i.e., the balance in its CCEE pool) from income from any source. For firms which incur exploration and development expenditures outside of Canada, these expenditures may be deducted up to the greater of foreign resource profits or 10 percent of the unclaimed foreign exploration and development expenditures. For purposes of deducting CEE, income is defined as net income for tax purposes computed without any inclusion in respect of recaptured depletion or any deduction for earned depletion (see below). The taxpayer may not create a tax loss by claiming CEE; however, any balance not deductible in the current year may be carried forward indefinitely and deducted in future years.

An important difference between CEE and other capital deductions such as CCA and CDE (discussed below) is the *mandatory* nature of the deduction for *principal business corporations*. A principal business corporation (PBC) is a corporation whose principal business is: (1) production, refining or marketing of petroleum, petroleum products or natural gas, or exploring or drilling for petroleum or natural gas; (2) mining or exploring for minerals; (3) processing mineral ores to recover metals therefrom; (4) fabricating metals; (5) operating an oil or gas transmission line; or (6) producing or marketing sodium chloride or potash. PBCs *must* deduct the lesser of the corporation's CCEE pool at the end of the year and its income for the year. This may be contrasted with CCA and CDE, where the claim is entirely discretionary. The mandatory nature of the CEE claim can be important when the corporation has unused loss carryforwards and/or investment tax credits that are due to expire. (This will be clearer below when tax losses are discussed.) For non-PBCs the CEE deduction may be taken at the taxpayer's discretion.

Any government grants or assistance related to exploration activities received by the taxpayer reduce the amount of expenditures eligible for CEE.

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4 Moreover, if an expenditure is treated as an operating cost rather than class 12 or CEE, firms cannot carry the deductions forward indefinitely. See the discussion on losses below.

Canadian Development Expenses (CDE)

For mining firms, CDE consists primarily of expenditures undertaken to acquire a Canadian mining property. Eligible expenditures include the costs of property rights and, where property is acquired from the Crown, certain Crown bonus costs (i.e., initial bonus payments). These costs are accumulated in the CCDE pool, which is reduced by the deduction taken every year. Corporations may deduct up to 30 percent of the unclaimed balance in the CCDE pool at the end of each year. Such deductions are thus made on a 30 percent declining balance basis.

Unlike CEE, the CDE claim is optional for all corporations, regardless of their PBC status. Moreover, CDE claims may be used to create a non-capital loss eligible for carryover. Like CEE, any grants or assistance received reduce the taxpayer's CDE.

When a taxpayer disposes of a Canadian Resource Property the proceeds of disposition reduce the taxpayer's CCDE balance. If the CCDE balance becomes negative, this amount is included in the taxpayer's income and is fully taxable.

Earned Depletion Allowance

Aside from the deduction for expenditures incurred in exploring for and developing metals and minerals, taxpayers are allowed an additional deduction called the *earned depletion allowance*. The amount of this allowance that may be claimed in a taxation year depends upon the taxpayer's resource profits for earned depletion purposes (defined below), and current and past expenditures on exploration and development and certain depreciable assets.

The earned depletion system that existed prior to the 1987 tax reform proposals had been in effect since 1976 and works as follows. Taxpayers may add to their earned depletion base (defined below) a specified percentage of eligible expenditures (33 1/3 percent). In the computation of taxable income, the taxpayer may then deduct the lesser of the balance of the earned depletion base or 25 percent of resource profits for earned depletion purposes. The earned depletion base is then reduced by amounts claimed, with unclaimed balances carried forward indefinitely. Thus, while the taxpayer must "earn" the depletion allowance by undertaking eligible expenditures, the timing of the deductions may depend on the level of resource profits earned by the firm.

Generally speaking, the taxpayer earns depletion on amounts expended on the exploration and development of minerals up to the point of production, and on amounts spent on physical capital used to process minerals up to the prime metal stage. Specifically, the following expenditures are eligible to earn depletion:

- Canadian exploration and development expenditures (CEE and CDE) *except:*

- capitalized interest, and *indirect* overhead expenses the cost of resource properties;
- expenses relating to and in the vicinity of the mine *after* the commencement of production from the mine;
- the cost of mining or processing assets eligible for Class 28 treatment;
- the cost of other processing machinery and buildings not in Class 28 used for processing up to the prime metal stage (i.e., certain Class 10 assets).

Like CEE and CDE, expenditures eligible for earned depletion are reduced by any tax credits and any other form of assistance or grants received.

The taxpayer may add 33 1/3 percent of these expenditures to the earned depletion base. The earned depletion deduction (which decreases the earned depletion base for subsequent years) is then the lesser of the balance in the earned depletion base or 25 percent or resource profits for earned depletion purposes, which consists of:

- the sum of
  - resource profits for purposes of the resource allowance (see below);
  - CEDOE (see below); and
  - proceeds from the disposition of Canadian resource properties;
- less
  - the resource allowance;
  - CEE and CDE;
  - interest expense related to resource profits.

There is one exception to the limitation on the earned depletion claim to 25 percent of resource profits. Since the April 1983 budget, depletion earned on grassroots exploration expenditures has been deductible against income from any source, rather than just against resource profits (as defined above). The deduction is still limited to 25 percent of this income. This provision is particularly important to junior mining companies and flow-through shareholders (see below) who may not have resource profits. The deduction for depletion earned on non-grassroots exploration is still limited by resource profits.

When a taxpayer disposes of an asset the cost of which generated an addition to the earned depletion base at the time of the original expenditure, a corresponding percentage of the proceeds of disposition is included in income in order to "recapture" the earned depletion claimed. The taxpayer must thus include in income 33 1/3 percent of the lesser of the original cost of the asset and the proceeds of disposition. A minor relieving provision exists in that the taxpayer is allowed to claim a depletion allowance against this income inclusion of 100 percent rather than the 25 percent on other resource profits (see above).

The earned depletion is designed to provide an incentive to undertake eligible expenditures. For every $3 of eligible expenditure undertaken, the taxpayer receives an *additional* write-off of $1, over and above the normal write-offs available for these expenditures. The historic rationale for depletion allowances is to compensate mine owners for the reduction in the value of their assets as deposits are depleted. The already accelerated write-off of the costs of acquiring the deposits (via CEE and CDE) and the lack of a connection between the allowance and the actual rate of depletion render this justification invalid for the earned depletion system described above. "Depletion Allowance" is thus a misnomer, as the allowance is not related to the depletion of the natural resource. Instead, it is an incentive to undertake eligible expenditures.

Flow-Through Shares

Flow-through shares are a mechanism which allows resource corporations that are not in a position to pay taxes (i.e., are in a loss position for tax purposes) to pass, or flow through, their deductions for exploration and development expenditures through to shareholders. The mining company issues equity flow-through shares, the proceeds of which are used to finance designated exploration and development activities. The corporation then renounces the relevant expenditures to the investors. For income tax purposes, the exploration and development expenditures are considered to have been incurred by the flow-through shareholders, not the mining company itself. Investors in the shares may therefore claim the related CEE and CDE deductions and, in the case of eligible exploration expenditures, earned depletion. These expenses are written off by the shareholders at their relevant personal tax rate. To be eligible for flow-through share treatment, the shares must be held by investors for at least one year before they are sold.

For capital gains tax purposes, the adjusted cost base of flow-through shares is deemed to be zero (see the discussion on CCA below for a more extensive explanation of the capital gains tax system). This means that the entire proceeds from the sale of the shares is treated as a capital gain rather than just the excess of the proceeds over the cost of the asset.[5] This provision is designed to take account of the reduction in the effective cost of flow-through shares due to the availability of the tax deductions. For example, the effective purchase price of a flow-through share issued in respect of exploration expenditures would be as follows:

5 If the taxpayer treats the security as inventory for tax purposes, the proceeds from sale would be treated as ordinary income rather than a capital gain.

Cost	100
Value of CEE*	(50)
Value of earned depletion*	(17)
Effective cost	33

* Assumes a 50 percent pre-reform personal tax rate for the investor.

The present value of the tax benefits embodied in a flow-through share should be capitalized in the equity market value of the share. This is how the mining company is able to realize the tax benefits of the unused deductions. If the premium of the flow-through share arising from the benefits exceeds the expected present value of the foregone deductions to the mining company, then it is in the best interests of the firm to issue the shares and renounce the deductions.

Capital Cost Allowances (CCA)

One of the most important deductions allowed under the Income Tax Act in respect of capital expenditures is the capital costs allowance (CCA). A prescribed capital cost allowance is deducted on account of depreciation for most depreciable capital. Eligible expenditures include most tangible depreciable assets. Expenditures on exploration and development, and mineral and property rights are not eligible for CCA but receive special treatment, as discussed above. The cost of land is not depreciable for income tax purposes, nor is depreciation allowed for inventories (to be discussed below).

Like CEE and CDE, the CCA system works on a pool basis, with separate classes and rates defined for various classes of assets. The original capital cost of a depreciable asset is added to the appropriate class as defined in the Income Tax Regulations, and is amortized together with all other assets in that class. Associated with each class is a CCA rate, which is applied to the total undepreciated balance in the class at the end of the taxation year; all assets in each class are thus written off together rather than individually. Except for certain assets described below, the balance in each pool is decreased at the end of the year by the CCA claim for that class and by any dispositions of capital assets in the class (i.e., the declining balance method with a constant CCA rate). Of course, the balance in each pool may not actually decline as the cost of assets purchased in the year are added to the class.

For certain CCA classes, the straightline depreciation method is used, with write-offs claimed in equal annual amounts over a prescribed period. For example, expenditures on class 29 assets (used in manufacturing and processing) and class 34 assets (used in energy conservation) are written off over a two-year period with 50 percent of the original cost of the asset claimed in each year (not taking account of the half-year convention, discussed below). Moreover, new mine assets (class 28), although subject to a basic declining

balance CCA rate of 30 percent, may be completely written off up to income generated from the mine.[6]

Regulations require that, in the year of purchase, only one half of the eligible depreciable cost of an asset may be added to the appropriate CCA pool, with the other half added in the following year, regardless of when the asset was actually purchased in the year. This "half-year convention" is in lieu of a "put-in-use-rule" for investments made during the year. A put-in-use rule only allows tax depreciation to begin when the asset is actually placed in service. Thus, the implicit assumption in the half-year rule is that all assets are put into service in the year of purchase and that they are purchased and/or disposed of exactly half-way through the year.

The amount added to the CCA classes must be reduced by the investment tax credit (discussed below) and any other forms of government assistance (such as grants, forgivable loans, etc.). This provision is intended to ensure that the taxpayer does not receive a cumulative write-off in excess of the total outlay for the asset.

There are thirty-seven CCA classes defined in the Income Tax Act Regulations; the classes most important for the mining industry are listed below (the write-off rate for each class which existed prior to the 1987 Tax Reform is shown in brackets, with "db" referring to a declining balance rate and "sl" to a straightline rate):

Class 10 (30 percent db) mine buildings and structures, mills, smelters, on-site office buildings, and mine machinery and equipment purchased *after* the start of commercial production from the mine, including "social" assets ancillary and in support of the mine, such as airports, hospitals, schools, etc.;

Class 28 (minimum 30 percent db — maximum 100 percent) mine buildings and structures, mills, smelters, on-site office buildings, and mine machinery and equipment purchased *prior* to the start of commercial production from a new mine or major mine expansion (defined as an increase in capacity of at least 25 percent), including ancillary "social" assets (see Class 10);

Class 3 (6 percent db) off-site buildings and structures;

Class 29 (50 percent sl) assets used for the manufacturing or processing of mine ore beyond the prime metal stage;

Class 12 (100 percent) expenditures on mine shafts, main haulage ways and other underground work, costs associated with the removal of overburden, etc., incurred *after* the start of commercial production from the mine (similar costs incurred prior to production are treated as a Canadian Exploration Expense).

With the exception of class 12, prior to tax reform the half-year rule applied to all of the above classes. Thus the 50 percent straightline rate for class 29, for example, actually amounts to an effective 25 percent-50 percent-25 percent

6 As will be discussed below, the CCA system was altered in the 1987 Tax reform.

straight line write-off over three (tax) years, while class 10 assets receive an effective 15 percent write-off in the first year, and 30 percent of undepreciated capital cost thereafter. For example, a $100 Class 10 asset eligible for a 10 percent investment tax credit would generate a maximum deduction of $13.50 in the year of purchase [100 x (1-.10) x .15 = 13.50], $22.95 the next year [(90 13.50) x .3 = 22.95], $16.065 in year three [(76.50 22.95) x .3 = 16.065, and so on.

Class 28 is a special accelerated CCA class for the mining industry. It was introduced in 1972 as a replacement for the three-year tax holiday for new mines. While the (pre-tax reform) basic CCA rate on class 28 assets is fixed at 30 percent, an additional deduction is allowed equal to the lesser of (i) the taxpayer's income for the year from the mine for which the assets were purchased, or (ii) the undepreciated capital cost of the class at year end. Thus, the CCA on class 28 property for a particular mine is the greater of 30 percent or the income generated from that mine, and can reach 100 percent if income is high enough.[7]

Three notions of income were discussed above: book, taxable, and economic. This distinction is particularly important in the treatment of the cost of depreciable assets, and it is useful at this point to note the differences between book, tax and economic depreciation. Book depreciation is the depreciation deduction used to calculate the firm's book income. It is usually based upon an estimate of the rate at which an asset will actually wear out over time and may take many forms; straightline, declining balance, sum-of-years digits, etc. Tax depreciation is determined in accordance with the CCA rules described above. There need not be a link between the CCA rate and the book depreciation rate used by firms; both are essentially artificial constructs. Indeed, capital costs are often written off at a higher rate for tax purposes than for book purposes.[8] Economic refers to the rate at which the real value of an asset falls over time due to wear and tear, obsolescence, and changes in its own price (capital gains or losses). Since, unlike tax or book depreciation, economic depreciation takes into account the revaluation of the capital good due to price changes, economic depreciation may be higher or lower than tax and book depreciation, depending upon the circumstances. When the CCA rate is accelerated, tax depreciation tends to be higher than both book and economic depreciation. On the other hand, in periods of high inflation, book and tax depreciation may be lower than economic deprecia-

7 The half-year convention applies to the additional class 28 deduction as well as the 30 percent basic deduction. Thus, in the year of purchase at most 50 percent of the capital expenditure may be claimed as CCA.

8 Accelerated CCA claims for tax purposes give rise to "deferred taxes" on a firm's books, as tax payments are initially lower than they would be if book depreciation were used.

tion. This is because book and tax depreciation are based on the original cost of the asset and are not indexed for inflation, while economic depreciation reflects the actual replacement costs of the assets.

The sale of a capital asset may result in two types of income inclusion: a recapture of CCA, and/or a capital gain. Upon the sale of a capital asset the relevant CCA pool is decreased by the lesser of the proceeds of disposition from the sale of the asset or its original capital cost. A recapture of CCA arises whenever the undepreciated capital cost of a class falls below zero at the end of a fiscal year. When this occurs the undepreciated capital cost is reinstated to zero and the negative balance included in income as recaptured CCA. If the last asset in a class has been disposed of and a positive balance remains for that class, that entire amount may be deducted as a terminal loss.

It should be stressed that recapture and terminal losses are class concepts; they relate to CCA classes, not individual assets. When an individual asset is disposed of and the appropriate CCA class is reduced by the proceeds of disposition, the balance in the class may or may not turn negative. If it does turn negative, then recapture takes place immediately via an income inclusion. If it does not turn negative, then recapture takes place over time, since future CCA claims from that class will be lower as the CCA rate is applied to a lower undepreciated capital cost. Note that the latter is more generous to the firm since the present value of reduced future CCA claims is less than the value of an immediate income inclusion.

Capital gains, on the other hand, relate to individual assets. If an asset is sold for an amount greater than its original cost, a capital gain is realized. In the pre-tax reform system, one-half of the capital gain is included in income. If an asset is disposed of at less than its original cost, a capital loss arises. Depreciation is ignored in the computation of capital gains and losses. Capital losses can be deducted only against capital gains. Note that the disposition of a capital asset at a gain does not necessarily imply an immediate recapture of CCA, as the balance in the class may still be positive after the disposition of the asset. It is also important to note that, while the disposition of a depreciable asset gives rise to a capital gain if sold at a price in excess of the original cost, the sale does not generate a capital loss if the asset is sold at a price less than cost. This prevents a double deduction of capital losses and terminal losses (or recapture).

A few simple examples are given in table 1 to clarify the operation of these two concepts. These examples are taken from the *Canadian Master Tax Guide*, 1986, p. 259.

In cases I and II, the amount deducted from the UCC is the actual proceeds from the sale of the asset, while in cases III and IV the UCC is reduced by the original cost of the asset. Moreover, an immediate recapture occurs only in cases II and III where the amount deducted from the UCC exceeds the balance before the sale. In cases I and IV, there is no immediate recapture as the UCC

Table 1:
Comparison of CCA Recapture and Capital Gains Treatment

	Case			
	I	II	III	IV
Cost of total assets in class	100	100	100	100
Accumulated CCA claims for class	80	80	80	50
Undepreciated capital cost (UCC) of class before sale of assets	20	20	20	50
Disposition of assets in class:				
Original capital cost	30	30	30	10
Proceeds from sale	15	25	35	25
Amount deducted from UCC[a]	15	25	30	10
Capital gain[b]	0	0	5	15
Amount recaptured	0	5	10	0
UCC of assets left in class	5	0	0	40

Source: *Canadian Master Tax Guide*, 1986, p. 259.

[a]Lesser of capital cost or proceeds from sale.

[b]The taxable capital gain is one-half of the capital gain.

remains positive after the sale of the asset. Note finally that, as in case IV, there can be a capital gain with no immediate recapture if the UCC of the class prior to the sale is greater than the original cost of the asset.

CCA deductions are entirely discretionary and may or may not be claimed when the taxpayer has no taxable income. In any year the taxpayer has the option of claiming less than the maximum amount of CCA available for any class without losing the unused deduction. Any unclaimed balances in the CCA pools may be carried forward indefinitely. There are a number of reasons why it may not be desirable to claim the full CCA deduction or to take a CCA deduction when taxable income is zero. These will be discussed below in the section on tax losses.

The Resource Allowance

Prior to 1974, resource corporations were allowed to deduct fully all provincial royalties and mining taxes for corporate income tax purposes. Concern by the federal government over the erosion of the federal tax base due to provincial Crown charges led to the non-deductibility of royalties and provincial mining taxes in 1974. Firms may now deduct a resource allowance instead. The resource allowance is equal to 25 percent of specified resource profits. Resource profits are computed prior to deductions for CEE, CDE, earned depletion, and interest but after the CCA claim and operating costs. Note that only CCA claims

related to the earning of resource income reduce the base upon which the resource allowance is calculated. Income from the following sources is eligible for the resource allowance:

- the production of minerals or metals up to the prime metal stage;
- the processing (i.e., concentrating, smelting, or refining) of ore from mines not operated by the taxpayer;
- rentals or royalties, the amounts of which are computed with reference to the value of production from the mineral resources.

Resource profits for purposes of the resource allowance do not include the proceeds from the sale of resource properties.

An important point to note is that the resource allowance is computed *after* the CCA deduction but *before* the deduction for interest, CEE, CDE, and earned depletion. Thus, the resource allowance has the effect of reducing the (pre-reform) federal statutory tax rate from 36 percent to 27 percent on qualifying income [.36 x (1 .25) = .27] without reducing the tax saving related to the deduction of interest and exploration and development expenses. Essentially, interest expenses and exploration and development expenditures are deducted at a higher rate (36 percent) than that at which the associated net (of operating costs) revenue stream is taxed (27 percent).

Interest

Another cost of a capital asset is the interest incurred in financing its acquisition. Interest on debt, including compound interest, is fully deductible for corporate income tax purposes. As with most of the other deductions, it is necessary to differentiate interest incurred in respect of funds borrowed to finance resource activities from interest incurred to fund other investment activities. This is not a straightforward exercise; the only guidance the Income Tax offers is that the allocation between activities must be "reasonable" given the circumstances.

Taxpayers are not required to deduct interest immediately as it is incurred; they may elect instead to capitalize all or a portion of the interest in respect of money borrowed to finance CEE, CDE, the acquisition of depreciable property or land. This may be desirable when the firm does not expect to be in a taxpaying position for some time and there is a danger that operating losses may expire (see below). When interest is capitalized it is merely added to the appropriate pool and written off at the corresponding rate with the other capital expenditures.

Although the tax system allows the deduction of debt interest, this deduction does not fully capture the true opportunity cost of holding capital. Capital outlays may also be financed through the issuance of shares or by retentions of income accruing to shareholders. When a capital asset is financed in one of these ways, not only does it generate a stream of revenue, but there is an implied

cost equal to the interest on the funds used to purchase the asset. Under debt financing, the interest costs can be interpreted as the opportunity costs of the capital, and these costs are deductible for tax purposes. When the capital is financed through either equity or retained earnings, the investment of the funds in physical capital involves a real cost to shareholders, yet in this case there is no deduction allowed for tax purposes.[9]

Although the above feature of the tax system allows too little of a deduction for the opportunity cost of capital, it can be offset in periods of inflation since the deduction of *nominal* debt interest payments is too generous. Nominal interest payments are fully deducted from the tax base, yet they reflect the anticipated fall in the purchasing power of the debt's principal due to inflation. Thus, the deduction of nominal interest payments amounts to allowing a portion of the debt's principal to be deducted.

Inventories

Goods held in inventory may be classified either as goods held for subsequent sale, or as goods held for the purpose of being processed, fabricated, manufactured or otherwise incorporated into goods that will subsequently be sold. There are three types of costs in holding inventories. The first is the cost of storing the goods. These costs are fully deductible for tax purposes as they accrue. Second, there is the opportunity cost of financing the inventory. Like other forms of capital, only interest on debt is deductible. Finally, there is the cost of acquiring or purchasing the inventory items themselves. These costs are deducted on an accrual basis according to the first-in, first-out (FIFO) principle. This means that when an item is removed from inventory it is valued for tax purposes at the cost of the oldest item introduced in the inventory. The use of FIFO implies that the deduction for the inventory item is less than its replacement value in times of inflation. This means that the tax deduction is less than the true imputed cost of holding the inventory, which gives rise to the taxation of inflationary profits. In order to offset partially the taxation of inflationary inventory profits, a special deduction known as the inventory allowance was available from 1977 to 1986. This deduction was equal to 3 percent of the costs of opening inventories (other than real property).[10]

9 Dividend payments by corporations to shareholders are not deductible; however, deductions are allowed for some of the costs of issuing shares, such as legal, printing and accounting expenses (but not dealer commissions).

10 As is discussed below in the section on Tax Reform, the inventory allowance was eliminated in 1986.

Tax Losses

Since 1983 non-capital losses (operating losses) may be carried back three years and forward seven years and deducted to reduce taxable income. Losses that remain unused after seven years expire and may no longer be deducted.

As mentioned at various points throughout the above discussion, some deductions may be used to create an operating loss for tax purposes while others may not. Operating costs, non-capitalized interest and other current deductions can all be used to create an operating loss. Of the other three major deductions (CCA, CDE, and CEE), CCA and CDE may be used to create an operating loss while CEE cannot. CCA and CDE deductions are also discretionary, so that if it is not advantageous for a taxpayer to create a loss, the deductions may be postponed and carried forward indefinitely. CEE may not be used to create a loss since the claim is limited to the greater of the amount in the CCEE pool or net income. The CEE deduction is mandatory for PBCs, and is lost if not claimed when net income is positive.

The mandatory versus discretionary nature of the capital deductions and its interaction with the loss carryover system can be important. As mentioned previously, there may be times when it is advantageous for the taxpayer to claim less than the maximum CCA (or CDE) deduction available. For example, taxable income may be zero or negative without the full CCA claim and the taxpayer may not wish to create a tax loss that may not be fully usable over the seven-year period (recall that unclaimed CCA and CDE are carried forward indefinitely). A less than maximum deduction may also be advisable when there is a danger that prior year operating losses (and/or unused investment tax credits — see below) may expire. In this situation it is preferable to postpone the CCA deduction rather than lose an operating loss deduction created in a previous year.

Under different circumstances it may be advisable to use certain CCA or CDE claims to create a tax loss. For example, when taxable income is expected to be large in the near future, the conversion of CCA and CDE deductions into reported tax losses allows the taxpayer to write the expenses off as quickly as income is earned.[11] This is better than keeping the deductions in the tax pools and writing them off at a slower rate when taxable income turns positive. For assets with low CCA rates this conversion of CCA deductions into tax losses may be particularly advantageous. Of course, there always exists the risk that the taxpayer's expectations regarding his future tax status may be wrong and the losses may expire.

11 For certain CCA classes, such as class 28 (new mine assets) and class 29 (manufacturing assets), unused CCA deductions are permitted in any one year. Thus, a firm can take full advantage of the unused deductions for those classes and there is no need to claim CCA earlier than necessary to create a reported loss.

It is thus evident that the income tax system in Canada allows losses to be carried forward either explicitly via the losscarry over rules or implicitly in the form of unused deductions in the tax pools. The former is subject to a time limit while the latter is not.

Another example of the interaction between the loss carryover system and capital deductions is the mandatory deduction of CEE. Recall that the CEE write-off rate is 100 percent with unused deductions carried forward indefinitely. Loss carryforwards must be deducted after the CEE claim and may be carried forward for only seven years. (As will be discussed below, unused investment tax credits may also be carried forward for seven years.) Firms with large CCEE pools may not, therefore, be able to claim prior year losses (and unused investment tax credits). Although firms in such a position may elect to capitalize interest and/or postpone CDE and CCA deductions in order to deduct the CCEE pool faster, this may not be sufficient to prevent the expiry of the losses.

Since 1985, taxable capital losses may be carried back for three years and carried forward indefinitely. Taxable capital losses may only be deducted against taxable capital gains, and are not allowed for depreciable capital.

The system of loss offsetting in Canada does not treat losses and profits in the same way. In a full loss offset system, profits and losses are treated symmetrically, with the government sharing the firm's income and losses at the same rate. The lack of full loss offsetting in the income tax system means that the imputed cost of risk taking on the part of the firm is not fully deductible, as the government essentially shares in the upside but not the downside of an investment. This will be discussed in more detail in subsequent chapters.

A full loss offset system could be achieved in two ways. The first method is to allow negative tax payments when taxable income is negative. The second approach is to allow losses to be carried forward indefinitely at an appropriate (riskless) rate of interest for deduction against future profits (assuming tax rates do not change). As discussed above, in Canada losses are allowed to be carried forward for only seven years (or back three) and the losses do not earn interest (although as mentioned above losses may be carried forward indefinitely in the form of unused deductions).

Tax Rates

Taxable income is determined by subtracting the various deductions discussed above from gross revenues. Basic federal taxes payable are then computed by applying the appropriate tax rate to taxable income. In 1985 the basic federal income tax rate applied to taxable income at the corporate level was 46 percent. This rate was reduced by a 10-percentage-point provincial abatement, to allow "room" for income taxes levied by the provinces. The net basic federal income tax rate on corporations was thus 36 percent. This rate could be further reduced

by the manufacturing and processing (M&P) deduction and the small business deduction (SBD).

The SBD is available to certain small Canadian-controlled private corporations (CCPCs) on the first $200,000 of active business income earned annually. In 1985 the rate reduction was 21 percentage points, so that the first $200,000 of small business income was taxed at a net rate of 15 percent.

The M&P deduction is available for income earned from manufacturing and processing activities. In 1985 the reduction was up to 6 percent of M&P profits (5 percent for CCPCs), yielding a net federal tax rate of 30 percent on manufacturing and processing profits (10 percent for CCPCs). Income generated from the processing or mineral ore beyond the prime metal stage (i.e., fabrication) is eligible for the M&P deduction.

In the 23 May 1985 Budget, a temporary 5 percent corporate surtax was imposed on large corporations commencing 1 July 1985 and ending 31 December 1986. The net basic surtax adjusted rate was thus 36.9 percent in 1985 (as the surtax was imposed half way through the year).

Investment Tax Credits

Federal taxes payable may be reduced by certain credits, the most important of which is the investment tax credit (ITC). Taxpayers have been able to reduce their federal tax liability by ITCs since 1975. These credits are tied to the cost of eligible *depreciable* property, such as buildings, and machinery and equipment, acquired for use in *qualified* activities in the manufacturing, resource, farming and fishing sectors. Expenditures on physical assets associated with the exploration, development, production and processing of minerals are generally included in the qualifying activities. Until the recent tax reform, most assets in classes 10, 28, and 29 earned the ITC, as did some assets in class 3. Class 12 assets generally are not eligible for the ITC. Moreover, ITC may be earned only on the purchase of new property; purchases of used capital are not eligible. Only physical depreciable capital may earn ITC; expenditures on CEE and CDE are not eligible.

ITCs reduce federal tax payable directly. In the event that the federal tax liability is less than the amount of available ITCs, the unused credits may be carried back for three years and forward for seven. A portion of unused ITCs may also be refunded in cash. The refundability rate is 40 percent for small corporations eligible to claim the small business deduction (see "Tax Rates" above) and 20 percent for other corporations.

As noted above, the amount of ITC that is actually utilized (claimed or refunded) in a taxation year reduces the capital cost of the related asset for purposes of computing CCA and earned depletion. Since ITCs do not reduce the CCA or earned depletion base until they are actually used, depreciation and

earned depletion may have to be recaptured at a subsequent date when the ITC is claimed.

The amount of ITC earned is calculated as a specified percentage of the cost of the qualifying asset (excluding any capitalized interest). The system is quite complex, as the rate of the credit depends both upon the type of asset and the area in Canada where the asset will be used. In 1985 the general ITC rate was 7 percent, which was available throughout the country. A 10 percent rate applied to property used in certain designated regions in Manitoba, Saskatchewan, the Northwest Territories, Yukon, British Columbia, Alberta, Ontario, and Quebec, while a 20 percent rate applied in Atlantic Canada. A special 50 percent rate existed for depreciable property used in manufacturing and processing in selected areas. A special 60 percent rate also existed in Cape Breton. Special rates were available for expenditures on research and development (R&D), again depending upon the region of the country (30 percent for R&D in the Atlantic region, 20 percent everywhere else, and 35 percent for small businesses everywhere).

The ITC rates discussed above are ITC rates gross of the reduction in CCA claims which arise when a credit is used. The requirement that the amount of ITC claimed reduce the capital cost of the asset for CCA purposes lowers the value of the ITC substantially, particularly for accelerated CCAS classes. This is because of the reduction in the (present) value of the CCA deductions associated with the asset. For example, consider a class 29 asset eligible for a 20 percent investment tax credit. The net value of the ITC is 11.8 percent. This is determined as shown in table 2.

Table 2:
Example Calculation of the Tax Benefit of Investment Tax Credits for Assets in Class 29

Investment	100	
ITC	20	(A)
Present Value of Reduction in CCAa	18.2	(B)
Tax Value of Reduction in CCA (B x .45)b	8.2	(C)
Net ITC Value (A - C)	11.8	

Source: Finance Canada, *Tax Reform 1987: Income Tax Reform*, Ottawa, 1987.

aAssumes a 10% discount rate. Recall that Class 29 assets receive a 25-50-25% write-off with the half-year rule.

bAssumes a combined federal/provincial tax rate of 45%.

PROVINCIAL INCOME TAXES

All provinces levy their own income taxes, although under the Tax Collection Agreements the federal government collects the tax for all provinces except Alberta, Ontario and Quebec. Provincial income tax bases are generally the same as defined at the federal level, with provincial tax liability determined by applying the appropriate provincial tax rate to the tax base described above. Some provinces, however, have special rules for calculating taxable income that differ from the federal rules. Ontario, Saskatchewan, Alberta, Quebec, and British Columbia in particular all deviate to varying degrees from the federal model. Some of the more important differences are discussed below.

As discussed earlier, the federal Income Tax Act does not allow a deduction for provincial royalties or mining taxes. In lieu of the deduction of royalty payments, a 25 percent resource allowance is granted. Alberta, Saskatchewan and British Columbia have provisions which effectively allow the deduction of these royalties and mining taxes for provincial income tax purposes. In all three provinces, the difference between the resource allowance claimed and the disallowed Crown royalites is allowed as a deduction. This result is actually achieved through a rebate system where provincial income taxes attributable to the excess of the disallowed royalties over the resource allowance is rebated. In British Columbia, when the resource allowance exceeds the disallowed Crown charges, the excess is included in income and taxed at the appropriate rate. There is no such income inclusion in Saskatchewan or Alberta when the resource allowance is too generous. A similar system is used for depletion allowances. Saskatchewan and Alberta calculate depletion deductions based on one-third of profits rather than one-third of qualifying expenditures.

Quebec generally follows the federal provisions with two important exceptions:

- like the federal system, earned depletion is available at the rate of one dollar for every three dollars in eligible expenditures. Unlike the federal system, however, earned depletion is claimable up to the lesser of 33 1/3 percent of mining income or the earned depletion base. Recall that federal earned depletion may only be claimed up to a maximum of 25 percent of resource profits (as defined);
- for Quebec income tax purposes the CDE rate is 100 percent rather than the 30 percent required for federal purposes.

Ontario also generally follows the federal rules, with the following deviations:

- for assets acquired prior to 24 October 1985 the half-year convention does not apply. Assets purchased after this date follow the federal rules;
- for Ontario income tax purposes, the CDE rate is 100 percent rather than the 30 percent required for federal purposes;

- the 25 percent resource allowance is not available to mining companies for Ontario tax purposes, nor is there a royalty rebate system;
- as of 18 December 1985 the 3 percent inventory allowance is no longer available for provincial tax purposes. (As we shall see in the discussion below on federal tax reform, the allowance was also abolished for federal purposes in 1986.);
- Ontario does not follow the federal earned depletion system. For Ontario provincial income tax purposes depletion is calculated as 33 1/3 percent of mining profits, rather than determined by expenditures on certain assets as is the case with the federal system. As such, in Ontario depletion is claimed automatically while for federal purposes the claim must first be earned by undertaking the appropriate expenditures.

Aside from these important differences, provincial income tax rules generally follow the federal system.

TAX REFORM

The system described above conforms to the corporate income tax regime in place up to the end of 1985. The most recent round of tax federal reform began in 1985 with the release of a Department of Finance discussion paper on restructuring the corporate tax system. One of the major objectives of the reform was to design a tax system in which taxpayers were driven more by "economic" motivations and less by tax considerations. The approach called for the elimination of various tax incentives ("base broadening") coupled with a reduction in tax rates in order to achieve a more "neutral" tax system.

Corporate tax reform has effectively been implemented in two phases. In the February 1986 Budget, Phase One began with some modifications to the corporate tax system designed to move the system in the direction suggested by the 1985 discussion paper. Phase Two commenced on 18 June 1987, with the release of the government's White Paper on Tax Reform. Many significant changes to the corporate tax system were announced, a number of which are particularly important for the mining industry. The White Paper also contained a number of fundamental changes to the personal tax regime and suggested options for a comprehensive restructuring of the existing federal sales system.

The 1986 Budget

In the 1986 budget, a phased-in reduction in the basic federal tax rate was announced.[12] The rate was to drop from its 1985 level of 36 percent to 33

12 The 1987 White Paper proposals call for a different, lower, set of tax rates in conjunction with a broader tax base. The proposals thus render the rate structure described below obsolete. However, the rate structure set forth for 1986 is presented here for completeness.

percent beginning in 1987 with full implementation by 1989. The rate reduction for manufacturing and processing profits was in percentage points, yielding a 26 percent M&P rate by 1989. Small Canadian-controlled private corporations were to receive a two-point reduction on the first $200,000 of income, from 15 percent to 13 percent (10 percent to 8 percent for manufacturing firms).

The federal corporate rate structure announced in the 1986 budget is shown in table 3, effective 1 July of each year.

Table 3:
Federal Corporate Tax Rates in 1986 Budget (percent)

	1986	1987	1988	1989 +
General	36	35	34	33
Manufacturing and processing	30	28	27	26
Small business	15	14	13	13
Small manufacturing	10	8	8	8

In 1986, the general surtax-adjusted rate was 37.8 percent for large corporations (recall that in the 1985 Budget a 5 percent surtax was imposed on large corporations which was due to expire on 31 December 1986). In the 1986 Budget, the surtax was extended to all corporations, at a lower 3 percent rate, effective 1 January 1987; no expiry date was announced. With the 3 percent surtax, the general effective statutory rate in 1987 is thus 36.05 percent. Since no expiry date for the surtax was announced, the potential rate would be 35.02 percent in 1988 and 33.99 percent in 1989.

A number of changes to the ITC system were also announced. These changes maintained the regional bias of the system by phasing out the general 7 percent and 10 percent rates while retaining the "special" rates for certain designated regions and activities. The ITC rates for 1987 and subsequent years announced in the 1986 budget were as shown in table 4.

The ITC refundability provisions (40 percent for small corporations and 20 percent for others) were due to expire in 1986 but were extended in the 1986 Budget to the end of 1988.

The Budget also eliminated the inventory allowance, effective 1 July 1986. Recall that the inventory allowance, equal to three percent of opening inventories, was designed to partially offset the taxation of inflationary profits due to the use of the FIFO costing system for tax purposes.

The 1987 Tax Reform

The changes announced in the 1986 Budget only partially implemented corporate tax reform by broadening the tax base and lowering tax rates. The June 1987 tax reform proposals went somewhat further in this regard. The most

Table 4:
Investment Tax Credit (ITC) Rates in 1986 Budget (percent)

	1987	1988	1989
Current 7% rate phase-out	5	3	0
Current 10% rate phase-out	7	3	0
Change in 50% rate for manufacturing in special ITC areas	40	40	40
R & D	unchanged from the current rates of 20, 30 and 35		
Atlantic region	unchanged from current rate of 20		
Cape Breton	unchanged from current rate of 60		

important changes which affect the mining sector are the overall tax rate reductions, the elimination of earned depletion, modifications to the CCA system, further reductions in ITC rates, and changes to the capital gains exemption which affect flow-through shares. These changes are discussed below.

Tax Rates

In the February 1986 Budget, corporate tax rates were reduced slightly to complement the elimination of the inventory allowance and adjustments to the ITC system. By 1989 the general corporate rate was to be reduced from 36 percent to 33 percent. The White Paper reduced tax rates even more in conjunction with a further broadening of the tax base. In 1988 the general corporate tax rate was 28 percent, five percentage points lower than the 33 percent rate for that year announced in the 1986 Budget, and seven points less than the 1987 rate of 35 percent.[13] Manufacturing businesses and small private corporations continue to be subject to preferential rates. The new corporate tax rates under tax reform are shown in table 5.

The 3 percent surtax on federal corporate income tax payable continues to be in effect with no specific expiry date. However, the proposals indicate that the surtax will be eliminated when sales tax reform is implemented.

Earned Depletion

For the mining industry, one of the most significant proposals in the tax reform package is the (phased) elimination of the earned depletion allowance. Recall

13 The rate reductions announced in the 1986 budget were to become effective on 1 July of each year. The rate in the first six months of 1987 was thus to be 36 percent and the rate in the last six months 35 percent.

Table 5:
Federal Corporate Tax Rates under 1987 Tax Reform (percent)

	1987[a]	1988	1989	1990	1991
General business	35	28	28	28	28
Manufacturing	28	26	25	24	23
Small business	14	12	12	12	12
Small manufacturing	8	12	12	12	12

[a]Effective 1 July 1987.

that under the pre-reform law, taxpayers earn depletion at the rate of 33 1/3 percent of eligible expenditures on exploration and development as well as certain depreciable assets. A deduction is then allowed, up to the lesser of the amount of unclaimed depletion and 25 percent of resource profits (except for depletion earned on grassroots exploration which can be deducted up to a maximum of 25 percent of a taxpayer's income from any source).

Under tax reform, the earned depletion allowance is to be phased out by reducing the rate at which new expenditures may earn the allowance to zero by 1990. Eligible expenditures incurred after 30 June 1988 earn depletion at a reduced rate of 16 2/3 percent, and after 30 June 1989 depletion on new investments is eliminated entirely. Any depletion earned prior to the elimination of the allowance in 1989 but unclaimed at that date is still eligible for deduction subject to the 25 percent limit (and may be carried forward indefinitely).

The elimination of earned depletion means that, after 1989, expenditures that were eligible for the allowance no longer give rise to a deduction in excess of the amount actually spent. However, the 100 percent write-off for grassroots exploration and pre-production development expenditures (CEE) is maintained, as is the ability to write off new mine assets up to the income generated from the mine (class 28).

Capital Cost Allowances

Tax reform maintains the basic structure of the current CCA system. However, a number of CCA rates are lowered and some assets are reclassified. With a few exceptions, the changes apply to assets purchased after 1987 (subject to various grandfathering provisions for projects in progress, pre-commitments, etc.). Assets purchased prior to 1988 continue to be written off at the existing rates (see above). The major changes affecting the mining industry are as follows (see above for a more in-depth description of the classes).

Class 10 (resource extraction property) — CCA rate lowered from 30 percent to 25 percent declining balance.

Class 28 (resource extraction property for new mines) — the basic CCA rate is lowered from 30 percent to 25 percent declining balance. The existing provision allowing an additional write-off up to the income from the new mine is retained. Moreover, the half-year rule no longer applies to the additional allowance.

Class 29 (manufacturing and processing machinery and equipment) — the current three-year 25 percent-50 percent-25 percent straight line write-off is to be converted to a 25 percent declining balance deduction by 1991. The conversion will be phased in, with assets purchased in 1988 written off at a 40 percent rate, and assets purchased in 1989 and 1990 written off at 35 percent and 30 percent respectively. Assets purchased after 1990 are to be written off at the 25 percent rate.

Class 12 (post-production mine shafts, mine haulage ways, overburden removal, etc.) — under current law these expenditures are included in CCA class 12 and written off at 100 percent. Under the proposal, these expenditures are treated as CDE and written off at a 30 percent declining balance rate. However, because CCA deductions reduce the value of the 25 percent resource allowance while CDE does not, the effect of the lower write-off rate is offset by its exclusion from the resource allowance base. As was the case for a class 12 asset prior to reform, the present value of the deduction is 75 cents per dollar expended (a $1 deduction less a 25 cent reduction in the resource allowance). At a 10 percent discount rate the present value of a 30 percent declining balance deduction is also 75 cents as the resource allowance is not reduced by CDE. This will be discussed in more detail in later chapters.

Class 3 (off-site buildings and structures) — the CCA rate is reduced from 5 percent to 4 percent declining balance.

As mentioned above, the basic structure of the current CCA system is essentially maintained with tax reform. There is one exception, however. A modified put-in-use rule is proposed which could be of some importance to the mining sector. Recall that, under current law, capital expenditures may be written off as they accrue without reference to when the asset is actually placed in service. This means that in some cases expenditures begin to be written off before the associated asset begins to generate revenue. Current legislation attempts to temper this "mismatching" of revenues and expenses by requiring that only one half of the cost of an asset be added to the appropriate CCA pool in the year of purchase. This "half-year" rule effectively halves the write-off rate for an asset in the year of purchase.

Even with the half-year rule, expenses and revenues can be seriously mismatched in some cases. For example, when equipment is stockpiled, acquired well in advance of delivery date, or when assets take a long time to construct, taxpayers may commence depreciation well in advance of placing the asset in service and prior to the generation of revenue. This may be particularly important for the mining industry, where it may take a number of years to construct

facilities. Even if a new mine is not generating revenue, taxpayers are entitled to a basic 30 percent (25 percent under tax reform) deduction for a class 28 asset. If the taxpayer is fully taxable, some assets may be almost fully written off before the individual mine actually begins production.

Under tax reform, a put-in-use rule will apply to all depreciable assets purchased after 1989. Under the proposal, taxpayers may not claim CCA or ITCs until the year in which an asset is available for service (or the year in which the construction of an asset, either by or on behalf of the taxpayer, is completed and the asset is ready for use). The half-year rule continues to apply to the fiscal period in which an asset is available for service. Thus, taxpayers may commence claiming CCA on depreciable capital halfway through the year in which the asset is placed in use rather than halfway through the year in which the asset is purchased (or the capital expenditure accrues).[14]

The Investment Tax Credit

In the 1986 Budget a phased reduction in the general 7 percent and 10 percent ITC was announced, as well as a 10-percentage-point reduction in the ITC rate for special designated regions. The ITC rates for R&D, the Atlantic region, and Cape Breton were maintained at their pre-budget levels. The tax reform measures, which became effective in 1988, reduce some of these remaining rates. Limits on annual ITC claims are also to come into effect.

While the current ITC rates are maintained for R&D, the rate for special designated regions is reduced from 40 percent to 30 percent, the rate of the Atlantic Canada ITC is lowered from 20 percent to 15 percent, and the Cape Breton ITC rate reduced from 60 percent to 45 percent. The new ITC structure is shown in table 6.

The new ITC rates coupled with the lower tax and CCA rate roughly maintain the relative incentive rate for eligible assets. Recall from above that the amount of expenditure eligible for CCA is reduced by the ITC. This lowers the net value of the ITC by reducing the present value of the CCA deductions. Without changes to the ITC rates, the reduction in corporate tax rates and lower CCA rates discussed above increase the net value of the ITC by lowering the associated reduction in the (present) value of the CCA deductions. ITC rates must be lowered to maintain the current net incentive rate. Previously, it was shown that the net value of the 20 percent ITC on a class 29 asset was 11.8 percent. Taking the new tax rates, CCA rates and ITC rates into account, and

14 In the tax reform legislation eventually tabled in the House of Commons, the put-in-use rule proposed in the 1987 White Paper, and described above, was modified such that it may not be as effective as envisaged in the original June 1987 proposals.

Table 6:
Investment Tax Credit Rates under 1987 Tax Reform (percent)

	1987	1988	1989
Current 5% rate	5	3	0
Current 7% rate	7	3	0
Change in 40% rate for manufacturing in special designated regions	40	40	30
R&D	unchanged from current rates of 20, 30 and 35		
Atlantic region rate reduction	20	20	15
Cape Breton rate reduction	60	60	45

using the same approach, reveals that the value of the proposed 15 percent ITC on class 29 assets is 10.9 percent.[15]

As well, the 1986 Budget extended the ITC refundability provisions to the end of 1988. Tax reform requires that the refundability provisions for large firms (20 percent) be ended one year earlier, at the end of 1987. For small corporations and individuals, the current 40 percent refundability rate for ITC that cannot be utilized in the year it is earned is extended indefinitely.

A number of amendments are also adopted which limit the extent to which ITCs may be used to reduce or eliminate taxes payable in a year. Prior to tax reform, there was no restriction on the use of ITCs, in the sense that they may be used to eliminate completely a taxpayer's tax liability. Under tax reform, this no longer is the case. In general, the maximum reduction in tax liability is limited to one-half of tax otherwise payable. The limit applies to both new ITC earned and to ITCs carried forward from previous years, although the limit does not apply to Canadian-controlled private corporations on their active business income eligible for the small business deduction. Moreover, for individuals and unincorporated businesses the maximum annual ITC claimable is $24,000 plus one-half of federal tax otherwise payable in excess of $24,000.

Flow-Through Shares

As discussed earlier, PBCs may renounce corporate tax deductions for exploration and development to holders of flow-through shares. This provision is retained under tax reform. However, changes to other aspects of the tax system

15 This assumes a combined federal-provincial tax rate of 38 percent and a 10 percent discount rate. See Department of Finance (1987).

tend to have a detrimental impact upon flow-through shares. Five factors are particularly relevant in this regard.

First, the elimination of earned depletion reduces the amount of eligible exploration expenditures that may be flowed through from 133-1/3 percent to 100 percent. Second, the type of shares eligible for flow-through status now excludes shares carrying an entitlement to a payment, guarantee or the equivalent. At the same time, the ability to flow through resource expenditures by partnerships to the partners is limited, under "at risk rules", to the amount of the expenditure that the partner has at risk. Third, the reduction in personal tax rates in the reform package lowers the value of the deductions flowed through to investors and therefore lowers the premium that flow-through shares attract. Fourth, the requirement that expenses relating to the issue of shares be amortized makes it more expensive to issue all types of equity. Finally, changes to the taxation of capital gains limit the extent to which capital gains arising from flow-through shares are eligible for the capital gains exemption.

The elimination of the earned depletion has significant implications for the attractiveness of flow-through share financing. Recall from the previous discussion of the pre-reform tax system, that the after-tax cost of a flow-through share purchased for $100 was approximately $33. The tax reform proposals would significantly increase the effective after-tax cost, as shown in table 7.

Table 7:
Effective After-Tax Cost of Flow-Through Investment under 1987 Tax Reform

Cost	100
Value of CEE[a]	(42)
Value of earned depletion	(0)
Effective cost	58

[a]Assumes a 42 percent post-reform personal tax rate for the investor.

Changes to the capital gains exemption will also have a significant impact upon the attractiveness of flow-through shares. As mentioned earlier, the adjusted cost base of flow-through shares is deemed to be zero for capital gains tax purposes. This means that the entire proceeds from the disposition of the shares is treated as a capital gain rather than just that portion in excess of the cost of the shares. The capital gains exemption introduced in the 1985 Budget was of significant benefit to holders of flow-through shares, since the tax on disposition of the shares was eliminated for exempt capital gains. Two changes to the exemption rules in the tax reform will have an important impact on flow-through shares. The first is the decrease in the lifetime exemption limit

from $500,000 to $100,000. The second is the cumulative net investment loss (CNIL) rules.

Prior to reform, individuals were able to claim the capital gains exemption on all taxable capital gains in excess of capital losses. Tax reform reduces net taxable gains eligible for the exemption by cumulative net investment losses claimed by the taxpayer. Investment losses are defined as the amount by which investment expenses exceed investment income. The orginal tax reform proposals introduced in June 1987 included as an investment expense any deductions flowed through to investors in respect of flow-through shares. This meant that the portion of the proceeds from the sale of shares eligible for the capital gains exemption would be reduced by any flow-through deductions claimed. The result was a virtual elimination of the availability of the capital gains exemption for flow-through shares on proceeds up to at least the purchase price of the shares. For example, say a flow-through share in respect of CEE is purchased for $100. The investor then earns a $100 tax deduction. If the taxpayer earns no investment income and the share is subsequently sold, say two years later, for $150, a capital gain of $150 arises (recall that the adjusted cost base for flow-through shares is deemed to be zero). However, only $50 is eligible for the capital gains exemption ($150 less the $100 cumulative investment loss). Seventy-five percent of the remaining $100 is then included in income under the new capital gains inclusion rules. Under the previous system, the entire $150 capital gain would have been eligible for the capital gains exemption. Moreover, if the investor had used up all of his exemption, only 50 percent of the $150 would be included in income under the old capital gains inclusion rules.

The impact of the tax reform proposals on flow-through shares spawned considerable negative political reaction after their release in June 1987. The elimination of earned depletion and the introduction of the CNIL rules for the capital gains exemption were particularly criticized. As a result of this reaction, in the legislation implementing tax reform eventually tabled in the House of Commons, the government took steps to reduce the impact of the the reform provisions on flow-through shares by introducing other incentives.

In order to mitigate the impact of the elimination of the earned depletion allowance, the government introduced the Canadian Exploration Incentive Plan (CEIP). Under this plan, mineral and oil and gas exploration companies can receive a grant equal to 30 percent of eligible expenditures financed by flow-through shares, to a maximum of $10 million of expenditures in any one year. These grants may be renounced by corporations and flowed through to shareholders along with the CEE deduction. The CEE deduction is reduced by the value of the grant. The result of the CEIP program is to lower the effective after-tax cost of flow-through shares, bringing them closer to the pre-reform level (which, for a $100 investment, was approximately $33), as shown in table 8.

Table 8:
Effective After-Tax Cost of Flow Through Investment, under 1987 Tax Reform and with CEIP

Cost	100
Value of CEIP grant	(30)
Value of CEE[a]	(29)
Value of earned depletion	(0)
Effective cost	41

[a]Assumes a 42 percent post-reform personal tax rate for the investor. Also, the CEE deduction is reduced to $70, which is the $100 investment less the $30 CEIP grant.

An important point to note is that only exploration expenditures financed by flow-through shares are eligible for CEIP grants. The obvious implication is that fully taxable companies may well find it worth their while to issue flow-through shares in order to receive the grant!

In a further attempt to pacify mining interests, the government modified the CNIL rules so that only 50 percent of resource deductions (such as CEE) flowed through to investors were counted as an investment deduction. This served to lower investors' capital gains tax liability upon disposition. Continuing the above example, if the shares were sold for $150, the amount eligible for the capital gains exemption would be $115 (the $150 deemed gain, less 50 percent of the CEE deduction of $70, which recall is determined by the $100 exploration expenditure less the $30 CEIP grant); this compares with $150 under the pre-reform system and $50 under the original tax reform proposals.

PROVINCIAL MINING TAXES[16]

The provincial mining system in Canada is complex. Rules vary both among provinces and within provincial jurisdictions. It is not uncommon for provinces to provide special treatment for specific types of mining or even individual corporations.[17] An in-depth technical examination of all of the provincial mining tax, royalty and related regimes in Canada is beyond the scope of this study. However, an attempt is made to discuss the relevant aspects of the more important systems as they currently exist. Most of the regimes described below

16 The material in this section is based largely upon the Price Waterhouse Publication "Canadian Mining Taxes", 1986, as well as the relevant provincial statutes as set forth in the Revised Statutes of the various provinces.

17 An example of a company-specific agreement for provincial mining taxes is that for the Iron Ore Company of Canada, which has a special tax agreement with the Newfoundland government regarding mining taxes.

apply to conventional mining operations which include base and precious mineral deposits and some industrial minerals. Royalty systems for the mining of hydrocarbon substances, such as coal and oil sands, are not discussed.

The discussion proceeds as follows. First, a very broad overview of a typical mining tax regime is presented. In this overview, the important features and concepts which characterize most (but by no means all) of the mining tax systems are discussed at a general level. Following this overview is a more in-depth examination of some of the more important provincial mining tax systems. Mining taxes are described for Ontario, Quebec, British Columbia, Manitoba, New Brunswick, Newfoundland, Saskatchewan, Alberta and Nova Scotia.

OVERVIEW

As discussed above, it is important to distinguish, for income tax purposes, among various stages in a mining operation. This distinction is also important for provincial mining tax purposes. Income from activities involved in processing the ore beyond the prime metal stage (manufacturing and processing operations for income tax purposes) is not subject to provincial mining taxes or royalties. Moreover, provincial mining taxes are not in general designed to be levied upon income generated by the processing stage — concentrating, smelting, and refining — but are typically intended to be imposed "at the pit's mouth", on income generated from true mining activities. In the case of an integrated operation, it is often difficult to separate income generated from the extraction of the raw ore from income arising from the processing of the ore. In this case the mining tax is typically levied upon total operating profits from the mine and a *processing allowance* is granted in order to prevent the taxation of income generated beyond the pit's mouth.

Most provincial mining taxes follow a "profits-based" principle, in that so as to determine the tax base capital costs are deducted over time, according to specified rates, rather than deducted in full as they are incurred (as would be the case with a cash-flow base). However, most systems do not allow financing costs to be deducted.[18] In order to determine the mining tax base, a number of deductions are allowed against revenue from mining activities. Aside from the deduction of normal operating or extraction costs, most regimes allow deductions for:

- exploration expenses;
- development expenses;
- depreciation of

18 Recall that a pure profits tax requires depreciation and financing deductions while a cash flow approach would allow capital costs to be expensed immediately in lieu of depreciation and financing cost deductions.

- mining assets
- processing assets (to the prime metal stage).

Exploration expenses refer to the costs of true grassroots exploration, which are usually deductible in full as incurred. Pre-production development expenses, similar to development type CEE for income tax purposes, are usually treated separately, with write-off rates ranging anywhere from 100 percent to nil.

Typically, mining assets are distinguished from assets used in the processing of the ore to the prime metal stage. Although the depreciation rates can be the same, physical processing assets are often written off for mining tax purposes at a lower rate than are assets used in the extraction of the ore. In both cases either declining balance or straightline rates may apply. There is no adjustment of the depreciation base for inflation.

Aside from depreciation allowances, expenditures on processing assets generate other deductions against mining income. Virtually every regime permits the deduction of a special processing allowance based upon the original cost of depreciable processing assets. The processing allowance is an annual deduction calculated as a specified percentage (ranging from 8 percent to 20 percent) of the original *(not the undepreciated)* cost of an asset used for the processing of ore up to the prime metal stage. The allowance rate often varies according to the type of processing involved — concentrating, smelting, and refining. What distinguishes the processing allowance from other capital deductions is the fact that it is applied annually to the original undepreciated cost of the processing asset. The base upon which the rate is applied is not reduced by the amount of the allowance claimed but rather remains fully intact (and the deduction made annually) until the asset is scrapped. Typically, limits are placed upon the maximum and minimum amount that may be claimed as a processing allowance. For example, the minimum claim may be equal to 15 percent of net mining profits and the maximum claim equal to 65 percent of net mining profits.

Processing allowances were originally conceived as a deduction to offset the taxation of income generated through processing operations. The size and scope of the allowances are currently so generous that in most cases they more than assure the non-taxation of processing income. It may also be noted that, although provincial mining taxes are typically not intended to be levied upon the income generated from processing activities, with processing allowances designed to assist in this goal, processing assets are also depreciated for mining tax purposes.

The following expenses are typically not allowed as deductions against income for mining tax purposes:

- the cost of the mining property;
- royalties paid to resource owners;

- depletion (with some important exceptions);
- administration expenses not directly related to the mining operation;
- interest and other financial charges.

With the exception of Quebec, none of the regimes have an explicit loss carryover system, although in most cases some write-offs are discretionary so that losses may be carried forward implicitly as unused deductions (see the previous deduction on losses in the corporate income tax system).

Mining tax rate structures vary across provinces. Some are flat rates (Newfoundland, 15 percent on 80 percent of income, 20 percent on the rest; B.C., 17 1/2 percent on base metals, 15 percent on others; Manitoba, 18 percent; Nova Scotia, 15 percent). Others are flat rate taxes applied after some deduction or credit (Ontario, 20 percent on profits above $500,000; Quebec, 18 percent with an annual credit of $90,000; New Brunswick, 16 percent of profits over $100,000; Alberta, 12 percent after recovery of capital and start-up costs). In Saskatchewan, the rates on potash and uranium profits are graduated, the rates increasing with the rate of return on investment (ranging from a rate of 0 percent when low rates of return are earned, to 50 percent when rates of return are earned above 40 percent in potash and 45 percent in uranium).

SPECIFIC PROVINCIAL MINING TAX REGIMES

Ontario (The Mining Tax Act)

The Ontario mining tax possesses many of the features outlined above in the general overview. Beginning with gross revenue from the sale of output from the mine, the tax base is calculated by deducting operating costs (related to extraction, processing and transportation), depreciation allowances, exploration and development expenditures, and a processing allowance.

The depreciation allowance is different for pure mining assets and processing and other assets. For mining assets depreciation is calculated on a 30 percent straightline basis, with a maximum claim equal to the income from the mine. Physical assets used for processing and transportation are written off at a lower 15 percent straightline rate. Expenditures on assets used in a new mine purchased prior to the start of commercial production may be deducted up to the income from the mine (similar to class 28 for federal income tax purposes). No depreciation may be claimed on "social assets", and since 1986 the depreciation base is reduced by most forms of government assistance including grants, subsidies, and investment allowances (such as the federal Investment Tax Credit).

Ontario allows exploration and development expenditures to be deducted fully as incurred, with unclaimed amounts carried forward indefinitely. Like physical assets, since 1986 the deduction must be reduced by most types of

government assistance. Expenses incurred in the acquisition of land and/or property rights are not deductible.

The processing allowance in Ontario is levied on the original cost of all processing assets, with the rate varying according to the degree of processing that takes place. Assets used in the concentrating process receive an 8 percent allowance, smelting assets a 12 percent allowance, and refining 16 percent allowance (20 percent in Northern Ontario). The minimum processing allowance claim is 15 percent of net income (prior to the processing allowance claim), while the maximum is 65 percent.

Prior to 1986, the Ontario mining tax rate was graduated, with the marginal tax rate increasing with net mining income. Currently, a flat rate of 20 percent is applied on mining profits in excess of $500,000 as determined above. The tax is applied to all mines owned by a taxpayer as a group (i.e., individual mines are not taxed separately, or "ring-fenced").

Quebec (Mining Duties Act)

Quebec's mining tax also follows the general model discussed above with one important exception. The usual deductions are allowed for operating costs, depreciation, exploration and development, and processing assets. However, Quebec offers an additional incentive in the form of a special investment allowance. This allowance is equal to one-third of the cost of new processing assets, expenditures on exploration and certain on-site development expenditures incurred after the beginning of production. The annual claim is limited to 33 1/3 percent of income prior to the deduction on the processing allowance. One might note the similarity between the Quebec investment allowance and earned depletion at the corporate income tax level.

The depreciation deduction in Quebec for mining tax purposes is 30 percent straightline for all physical assets (mining, transportation, and processing). Exploration and development expenses are fully written off as incurred with unclaimed amounts carried forward indefinitely.

The processing allowance rates are 8 percent for concentrating, and 15 percent for smelting and refining. The minimum claim is 15 percent of net income after the deduction of all other claims and allowances, with a maximum claim of 65 percent.

Like Ontario, Quebec used to have a graduated rate structure (ranging from 0 percent to 30 percent). In 1986, the graduated structure was abandoned in favour of a flat 18 percent rate on mining tax profits as calculated above. An annual credit of $90,000 is available which can be carried forward for three years.

The Quebec mining tax system also contains a number of rather unique provisions to account for losses. For companies actively involved in mining (as opposed to corporations whose activities are limited strictly to exploration) 18

percent of the lesser of a loss incurred in a year, or the sum of exploration and development expenses and depreciation allowances claimed in the year, is refundable. Quebec also allows a limited carryforward of mining tax losses — 18 percent of any loss incurred in a mining operation may be carried forward for up to seven years and back for up to three years.

Newfoundland (The Mining and Mineral Rights Tax Act)

Newfoundland's mining tax also closely follows the general concepts discussed in the overview. Taxable mining income is determined by deducting from gross revenue the usual claim for operating costs, depreciation, exploration and development and a processing allowance.

The depreciation rate is 10 percent declining balance for both mining and processing assets. While grassroots exploration expenditures are written off as incurred, pre-production/development expenditures are deducted over the estimated life of the mine on a straightline basis. The processing allowance is 8 percent of the original cost of eligible assets subject to a maximum of 65 percent of net income.

Newfoundland's regime does have some distinctive features. Other royalties paid to the province are fully deductible. Moreover, a type of resource allowance is allowed in recognition of royalties paid to other provinces. The deduction is equal to the amount of royalties paid or 20 percent of net income (after all other deductions), whichever is the greater.

The province has a two-tier rate structure, with a 15 percent rate for the first 80 percent of net mining income as calculated above, and 20 percent on the remainder. The "effective" statutory rate is thus 16 percent (.8x15 + .2x20 = 16).

British Columbia

British Columbia levies two mining taxes (1) the Mineral Resource Tax on income from base metal mining, and (2) the Mining Tax on income from the mining of coal, gravel, sand, shale, peat, and other industrial minerals.

The Mineral Resource Tax Act

The Mineral Resource Tax is modelled closely after the federal income tax system. The typical deductions are allowed for operating costs, depreciation, exploration and development, and a processing allowance, as well as an additional deduction similar to earned depletion. Unlike other provinces, British Columbia allows the deduction of interest expenses in excess of interest income.

The depreciation allowance for mining and processing assets mirrors the class 28 treatment for federal purposes — 30 percent declining balance up to 100 percent of income from the new mine or major expansion. Like the federal

income tax, British Columbia requires the depreciation base to be reduced by investment tax credits claimed. Also like the federal rules, both grassroots exploration and pre-production/development expenditures are 100 percent deductible.

A depletion allowance is available which is similar to the federal system. One third of eligible expenditures (expenditures on processing assets and exploration incurred in searching for minerals in British Columbia) is added to the earned depletion base. The maximum claim is then the lesser of the balance in the earned depletion account or 25 percent of net mining income before the processing allowance.

The processing allowance is equal to 8 percent of the original cost of all processing assets with a minimum claim of 15 percent of net income and a maximum of 70 percent. The mining tax is levied at a flat 17 1/2 percent rate.

The Mining Tax Act

The British Columbia Mining Tax Act also closely follows the federal income tax rules. The tax is levied at a rate of 15 percent on net taxable income.[19] Net taxable income is determined in accordance with the federal income tax rules with the exception that no deductions are allowed for:

- depletion allowances;
- the resource allowance;
- charitable donations made outside of the province;
- prior year losses.

Processing allowances identical to those granted under the Mineral Resource Tax Act are also available.

New Brunswick (Metallic Minerals Tax Act)

New Brunswick's mining tax deviates somewhat from the systems discussed to this point. The province levies a two-tier tax consisting of a 2 percent royalty on "net revenue" and a 16 percent tax on "net profits" in excess of $100,000.

The 2 percent tax is applied to net revenue, defined as gross revenue less all operating costs associated with the mining operations, milling and transportation, and a special allowance for processing assets. The special processing deduction is actually a processing allowance equal to 8 percent of the original cost of the assets used in concentrating activities and 15 percent of smelting and refining assets. The maximum allowable claim is 25 percent of revenue net of operating costs. Aside from the deduction for processing assets, no other capital deductions are allowed for the purposes of the net revenue tax. The 2 percent tax is not imposed in the first two years of a mining operation.

19 Coal mines are eligible for a thirty-six-month tax holiday at the beginning of production but must also pay an additional 3 percent gross revenue royalty.

The 16 percent net profit tax is imposed upon the following base: gross revenue less operating costs, the 2 percent net revenue tax, depreciation, exploration and pre-production expenses, a processing allowance and a special financing allowance.

The depreciation allowance for new mine and processing assets is a 5 percent declining balance minimum claim up to 100 percent of the income from the mine. Other assets not eligible for the accelerated write-off are depreciated at a 33 1/3 percent declining balance rate. Exploration expenditures are 100 percent deductible as incurred as well as earning an additional 50 percent deduction (thus exploration expenditures actually receive a 150 percent deduction). The additional 50 percent deduction for exploration expenses replaced a 25 percent tax credit that was available prior to 1982. Pre-production expenses are fully deducted as incurred, with a minimum annual claim of 5 percent (development expenditures are not eligible for the additional 50 percent claim). The processing allowance is equal to 8 percent of the original cost of concentrating assets plus 15 percent of smelting and refining assets, subject to a 65 percent maximum (there is no minimum claim).

Like the other provinces (except British Columbia), New Brunswick does not directly allow the deduction of interest. In lieu of interest deductibility, however, a special financing allowance is permitted. The allowance is equal to 8 percent of the undepreciated capital cost of depreciable assets. This is in fact equivalent to the deductibility of all financing costs (both debt and equity) when the weighted average cost of finance is 8 percent. The financing allowance is not indexed to inflation.

Manitoba (The Metallic Minerals Royalty Act)

Manitoba's mining tax also follows the general guidelines discussed in the overview. The deductions from gross mining revenue are operating costs, depreciation, an allowance for exploration and development expenses, and a processing allowance. The tax differs from the general model in the granting of a special investment tax credit.

Depreciation allowances are granted on a 20 percent declining balance base for both mining and processing assets. The depreciation base is decreased by mining tax investment tax credits claimed in the year (see below).

Pre-production expenditures are included with depreciable assets and written off at a 20 percent declining balance rate. Exploration expenditures are deducted fully as incurred.

The processing allowance in Manitoba is equal to 8 percent of the original cost of all processing assets, with a minimum deduction equal to 15 percent of pre-processing allowance income, and a maximum claim of 65 percent. An additional allowance equal to 25 percent of the 8 percent basic allowance is also available (for an effective processing allowance rate of 10 percent).

The mining tax rate of 18 percent is applied to net mining income as calculated above. Mining taxes payable are then reduced by a special investment tax credit equal to 5 percent of the cost of:

- the construction of new mining or processing facilities in the province;
- equipment to be used in the new mine or processing facility;
- the cost of approved major expansions;
- major alterations, renovations, etc. for the purpose of meeting prescribed environmental standards.

As mentioned above, credits claimed reduce the depreciation allowance base.

Saskatchewan

Saskatchewan levies mining taxes that differ according to the type of mineral. Two of the most important, the tax on potash and the tax on uranium, are discussed here. Both of these taxes are quite complex, each containing a number of unique provisions. Like the mining taxes discussed above, the potash tax is essentially a modified profits tax, with capital costs deducted according to specified rates, while the uranium tax is based on a cash flow concept, which allows all costs to be deducted as incurred (including capital costs).

The Potash Tax[20]

The tax on potash is a two-part tax consisting of (i) a base payment calculated on a per-unit-of-production basis, and (ii) a profits-based payment with a graduated rate schedule based upon the return to capital. Potash producers must also pay some Crown and freehold royalties. The royalties are calculated as a percentage of gross revenue, with the rate depending upon the grade of the ore (the minimum rate is 4.25 percent, which rises to a maximum of 9 percent for high grade ore). The Crown and freehold royalties (up to the level of the Crown royalties) are fully *creditable* against the base payment with excess credits *deductible* from the tax base of the profits tax.

The base payment is a per unit tax levied on the amount of potash (in K20 tonnes) sold in the year. The tax is $6.61 per tonne for the first 272,176 tonnes sold and $8.27 thereafter. As indicated above, Crown and freehold royalties may be fully credited against the base tax. The effective per-unit base rate may thus vary significantly from those specified in the regulations. In 1985/86 the net average base payment was $4.60 per tonne, which implies that Crown and freehold royalties were credited up to 3/8 of the base payment. In 1985/86 Crown royalties averaged $1.67 per tonne, while freehold levies averaged $1.03 per tonne; 23 percent and 14 percent of the base payment respectively.[21]

20 The Potash Reserve Tax was declared unconstitutional in 1987.

21 See Mintz (1987).

The profits tax is more complicated than the per unit base tax, as it allows a number of capital deductions and has a rather complex rate structure. The tax base is defined as gross sales less the following deductions:

i) operating, storage, and transportation costs;
ii) a marketing allowance (3 percent of sales net of transportation costs);
iii) a head office overhead allowance (2 percent of gross revenue);
iv) depreciation allowances (4.5 percent declining balance for pre-1979 capital and 10 percent for post-1979 capital).

Capital assets are also written off on a straightline basis. Capital assets include both physical and "intangible" capital associated with the mine's activity or expansion, including land, machinery and structures, and on-site exploration and development expenditures. Exploration and development is treated in exactly the same manner as physical capital. Other capital assets not directly related to the mine's activity are depreciated for potash tax purposes on a declining balance basis as follows:

- research and development - 30 percent;
- railway cars - 7 percent;
- automobiles - 35 percent;
- furniture and other equipment - 20 percent.

There is no processing allowance for Saskatchewan potash.

The total tax collected is calculated by applying the appropriate tax rate to the tax base as determined above. The tax rate is determined according to a graduated rate schedule where the rate depends on the rate of return on capital. The graduated rate schedule is shown in table 9.

Table 9:
Saskatchewan Potash Graduated Rates (percent)

Profit as a Percentage of Capital Investment Base	Tax Rate
0 - 5	0
5 - 10	10
10 - 20	20
20 - 30	30
30 - 40	40
40 and over	50

The return to capital used to determine the appropriate tax rate is operating profit as a percentage of the "capital investment account" which includes all assets that increase the capacity of the mine by more than 15 percent. If an asset

does not qualify for inclusion in the capital investment account, it is still depreciated as described above.

The Uranium Tax

Saskatchewan's approach to the taxation of the uranium industry differs from the potash tax described above. With some important deviations, the uranium tax is based upon a cash-flow principle, which, in its simplest form, involves a tax rate applied to a base equal to revenue less current costs and expenditures on capital outlays.

In order to ensure some current tax revenue, a basic royalty of 3 percent is levied on gross sales. A graduated royalty is then levied on operating profits. Operating profits are defined as gross revenue less:

- production costs;
- an administrative and corporate expenditure allowance;
- a marketing expense allowance;
- a working capital allowance;
- the basic 3 percent royalty;
- a depreciation allowance for social capital;
- a capital recovery allowance.

Rather than allowing overhead and marketing costs to be deducted as incurred, allowances are granted for these costs instead. These allowances are unrelated to the actual expenditures on overhead and marketing, but are determined as a percentage of sales or production costs. The administrative and corporate expenditure allowance is 5 percent of production costs (attributable to the production of uranium), the marketing expense allowance is 0.75 percent of gross sales, and the working capital allowance is an interest factor times 40 percent of production costs. These limitations were designed to prevent multinational corporations from deducting these types of costs incurred outside of the province from the Saskatchewan tax base. The problem is that the costs are deductible in other jurisdictions and the allowances may therefore be too generous.[22]

Expenditures on social capital (such as mine townsite and housing) are deductible on a 30 percent declining balance basis. All other capital expenditures (including exploration and development expenditures and most fixed assets) are deducted through a "capital recovery allowance" that works as follows. The expenditures are expensed immediately as incurred. However, the claim is limited to net profits calculated to that point, and the unused capital expenditures are carried forward at an interest rate of 15 percent. This is close

22 See Mintz (1987).

to a full-loss offset system since the loss is effectively carried forward at a rate of interest.

Like the potash tax, the uranium tax rate is graduated on the basis of the rate of return on investment. The rate structure is shown in table 10.

Table 10:
Saskatchewan Uranium Tax Graduated Rates (percent)

Operating Profit as % of Capital Investment	Tax Rate
0 - 15	0
15 - 25	15
25 - 45	30
45 and over	50

A tax credit of 35 percent of exploration expenditures is allowed against the graduated royalty payment.

Alberta (The Metallic Minerals Royalty Act)

Alberta has adopted a unique approach to the taxation of mining income. The basic idea behind the Alberta system is to allow the mine to recover all of its capital costs (i.e., achieve "payout") before levying the mining tax. A pre-payout royalty of 1 percent is levied until all capital and start-up costs are recovered. After the payout period, a 12 percent profits-based tax similar to that described in the general overview is imposed.

The pre-payout tax is equal to 1 percent of gross revenues determined at the pit's mouth less operating costs incurred beyond the pit's mouth (i.e., in processing) and a depreciation allowance calculated on a straightline basis of 15 percent of capital costs beyond the pit's mouth.

Payout is defined as the point in time when cumulative gross revenues equal cumulative operating costs plus cumulative capital costs plus cumulative pre-payout royalties plus a cumulative annual 15 percent capital allowance. Cumulative operating costs include the costs of operating the mine, mill and smelter to that point in time. Cumulative capital costs include eligible capital costs of the mine, mill and smelter plus all on-site exploration and development expenditures incurred to that point in time. The cumulative pre-payout royalty is determined by adding up all of the 1 percent royalty payments made to that date. The cumulative annual capital allowance is the sum of 15 percent of annual capital expenditures.

Once the payout point has been reached, the Alberta mining tax is the lesser of the 1 percent royalty described above and 12 percent of net income determined by subtracting the following costs from gross revenues:

- capital costs attributable to the mine, including on-site exploration and development expenditures;
- mine operating costs;
- operating losses carried forward from previous periods (excluding royalty payments);
- mine closing costs;
- a processing allowance.

The processing allowance deductible for purposes of determining the 12 percent post-payout royalty is 10 percent of the original cost of all processing assets (beyond the pit's mouth). The maximum claim is 65 percent of net profits to that point.

Nova Scotia (The Mineral Resource Royalty Act)

Nova Scotia levies a number of royalties at various rates on specific types of mineral resources. Aside from these specific royalties a mine may, at the discretion of the Minister of Mines, be required to pay tax under a second royalty system. This royalty requires the taxpayer to pay the greater of two amounts - 2 percent of net smelter income, or 15 percent of net mining income.

Net smelter income for purposes of determining the 2 percent tax is gross revenue less smelting, marketing and transportation costs.

Net income for purposes of the 15 percent tax is gross revenue less all operating costs, a depreciation allowance and a processing allowance. Depreciable costs include all of the physical capital costs of the mine, mill and smelter as well as exploration and development expenditures. The depreciation allowance is 100 percent of all eligible expenditures for the first three years of the mine's operation and 30 percent (straightline) thereafter. The processing allowance is 8 percent of the original cost of all processing assets up to a maximum of 65 percent of profits determined to that point.

3. Evaluation of the Impact of Taxation on the Mining Industry

The tax system can effect the business decisions of firms in a number of ways. Decisions regarding how much physical capital to employ, how much to expend on exploration and development, the size of inventories to hold, the rate at which to extract a depletable resource, the level of risktaking to engage in, the manner in which to finance various activities, and the location in which to undertake an activity, can all be influenced, to varying degrees, by the tax system. The objective of this chapter is to assess the impact of corporate income and mining taxes on these types of economic decisions by mining companies in Canada. In our evaluation, we will examine how these taxes impinge on mining activities in each of the provinces, taking into account the tax law that existed both prior to and after the recent federal corporate income tax reform.

The specific economic decisions that are of interest in this chapter are the following:

- expenditures on exploration and development;
- investment in extraction and processing assets;
- investment in inventories;
- the decision to extract the depletable resource;
- the location of investment (across provinces);
- risktaking;
- debt and equity financing.

We will also compare the impact of taxation on economic decisions taken by taxpaying and non-taxpaying firms. The use of tax losses is an important issue in the mining industry, as is exemplified by the recent debate regarding tax reform proposals that reduce incentives for the "flow-through" share financing of exploration and development expenditures for non-taxpaying corporations.

To assess the impact of taxation on these economic decisions, we utilize the concept of the marginal effective tax rate. (This will often be referred to as the marginal tax rate or just the effective tax rate in the discussion that follows.) As we will discuss below, this type of measure is the most appropriate for judging the incentive effect of taxes on the investment decisions of firms. The estimation of marginal effective tax rates to quantify the level of investment and expenditure distortions caused by the tax system has recently become popular in the economics literature. However, there have been few applications of the methodology to the resource sector; recent exceptions are Boadway, Bruce, McKenzie and Mintz (1987), and Boadway and McKenzie (1988).

The outline of this chapter is as follows. First we undertake a heuristic discussion of the concept of a marginal effective tax rate. For the more technically inclined, a formal treatment is contained in appendix A at the end of the monograph.

Next, we begin our evaluation of the impact of taxation on the mining industry with an examination of the effective tax rates on firms which are fully taxpaying, both currently and over all future periods (or, equivalently, for a full loss offset tax system), taking into account the type of activity that the firm engages in as well as the province in which the investment is located. In this section we ignore the issue of risk and uncertainty. We refer to this as our base case.

We then consider a number of special cases. The first of these cases is for investments which face different types of risk. The second considers the impact of taxation on investments for firms that may be non-taxpaying either currently or sometime in the future. In principle, there are a large number of tax loss cases that could be considered since effective tax rates on investments depend on the tax loss history of the firm and the uncertainty faced by it. We use data that provide information on the use of tax losses over time, but these data are aggregated over the entire industry. Thus, our results are only meant to be suggestive of the impact of taxation on investments undertaken by tax loss firms. The third special case is the impact of taxation on investment that may be financed in different ways. In particular, we compare debt- and equity-financed investments, and exploration and development expenses that may be financed by either new equity, flow-through shares or retained earnings.

All of the effective tax rate calculations discussed with reference to the base and special cases are computed for the federal corporate tax system that existed prior to the recent federal tax reform. An assessment of the impact of corporate income tax reform on mining investment and financing decisions follows the case descriptions. Thus, as discussed in chapter 2, we assume that in the pre-reform system the top federal statutory corporate tax rate is 36 percent and that the investment tax credit (ITC) and inventory allowance are in effect, and we use the provincial corporate tax rates and mining tax provisions measures that were in place in 1987. For the post-tax reform system, we use the provincial mining tax law of 1987 and the corporate tax laws introduced in February 1986 and December 1987, assuming that the tax measures are applied in full (i.e., after the phase-in period). To assess the impact of corporate tax reform on the mining industry, we compare effective tax rates estimated for the pre- and post-tax reform periods.

The chapter concludes with a summary discussion of how mining and corporate income taxes distort investment, financing and risktaking decisions.

EFFECTIVE TAX RATES: A CONCEPTUAL EXPLANATION

The way in which the tax system impinges upon the investment decisions of firms may be seen by considering the following simple idea: firms invest in all projects which yield a rate of return in excess of some "hurdle" rate required by the market. For investments that give rise to a stream of income over time (capital or depreciable expenditures), this hurdle rate is the market cost of funds, net of depreciation, where the market cost of funds is the weighted average of the interest rate on debt and the rate of return required by shareholders.[1] For example, if the cost of debt and equity finance is 11 percent and 9 percent respectively, and capital is financed by 50 percent debt, the hurdle rate is 10 percent. For expenditures that give rise to income immediately (current expenses) the analogous hurdle is simply the current market price of the expenditure. A *marginal project* is defined as one where the rate of return is just equal to the hurdle rate: i.e., the marginal project just breaks even.

All projects that earn a rate of return in excess of the hurdle rate (so-called *inframarginal projects*) are said to earn "rent" or economic profits, as discussed in chapters 1 and 2. A tax system is "neutral" or non-distorting if it does not influence the investment and expenditure decisions of firms. A system that taxes economic profits is neutral because the tax allows all of the (imputed) costs of investments to be deducted from the tax base; only the income on inframarginal investments is lowered. Although the tax lowers the after-tax rate of return on inframarginal investments, the investments are still undertaken since the return exceeds the hurdle rate. Since a marginal project earns just enough to cover the opportunity cost of the investment or expenditure, it earns no economic profits and it pays no tax if the tax system is neutral. For such a project the after-tax rate of return to capital is identical to the before-tax rate of return to investors, which in turn is equal to the hurdle rate.

If we assume for expositional purposes that investment and expenditure prospects are continuously divisible, firms will accumulate capital (or undertake expenditures) until the last increment just earns the hurdle rate of return: i.e., it earns just enough to cover all of its imputed costs, or just breaks even. If this were not the case, then the firm could increase its profits by either increasing or decreasing its investment appropriately. A non-neutral tax system may impinge upon the investment decision by affecting the rate of return earned by this last increment (which is the marginal investment).

This is best shown by way of example. Say the hurdle rate of return required by the market on a capital expenditure is 10 percent. This means that all capital projects that earn a rate of return in excess of 10 percent will be undertaken and the rate of return on the marginal project is exactly 10 percent. In other words,

1 A risk premium may be included as well. In the discussion that immediately follows we ignore risk. Risk considerations will be dealt with in more depth later on in this chapter.

a rate of return on capital of 10 percent is just sufficient to attract the owners' funds to the industry. That is, the owners could invest in alternative assets that yield the same rate of return on capital. Now consider the imposition of a non-neutral tax system. Suppose that, because of the tax, an investment must now earn a before-tax rate of return of 15 percent to earn an after-tax rate of return of 10 percent. By raising the before-tax rate of return required by the marginal project, the tax system reduces the incentive to invest. A project that was marginal before the tax is no longer viable and will not be undertaken. An analogous example could be constructed for an investment that is current in nature.

We measure the distortion to the investment decision caused by the tax by calculating the marginal effective tax rate. We define the effective tax *wedge* as the difference between the gross (before-tax) rate of return on a marginal investment and the net (after-tax) required rate of return to capital. The effective tax rate is the wedge divided by the net rate of return. In the above example the gross rate of return is 15 percent and the net rate of return to capital required by the market is 10 percent; the effective tax wedge is thus 5 percent, and the effective tax rate 50 percent.[2] In this case, investment will be discouraged because the effective tax rate is positive, and the tax system has thus increased the gross rate of return required by a marginal project.

The effective tax rate depends upon the structural characteristics of the tax system(s) in question. It can take on a wide variety of values. In the above example, the tax system discouraged investment by raising the gross rate of return on a marginal project above the net rate of return required by the market. The tax system may also act to encourage investment by providing a subsidy to marginal projects. For example, suppose the tax system is such that a before-tax rate of return of only 5 percent is required to yield 10 percent after-tax. In this case, the effective tax rate is negative 50 percent, and projects that were not viable before the imposition of the tax will now be undertaken.

The concept of an effective tax rate can be further illustrated with the aid of figure 1. The figure depicts a downward-sloping demand for capital schedule, KD (r_g), expressed as a function of the before-tax (gross) rate of return on capital (r_g). (Note we implicitly assume that all capital goods are homogenous; this is for illustrative purposes only, as we calculate effective tax rates for different types of capital decisions). The upward-sloping schedule, labelled KS(r_n) depicts the supply of capital forthcoming as a positive function of the after-tax (net) return to savings (r_n). The net rate of return reflects the imposition of personal taxes, which lowers the rate of return on savings. Equilibrium is determined when the supply of capital for a given net rate of return is equal to

2 We express the effective tax rate as the tax wedge relative to the net rate of return. Some authors prefer to define the effective tax rate as the tax wedge divided by the gross rate of return.

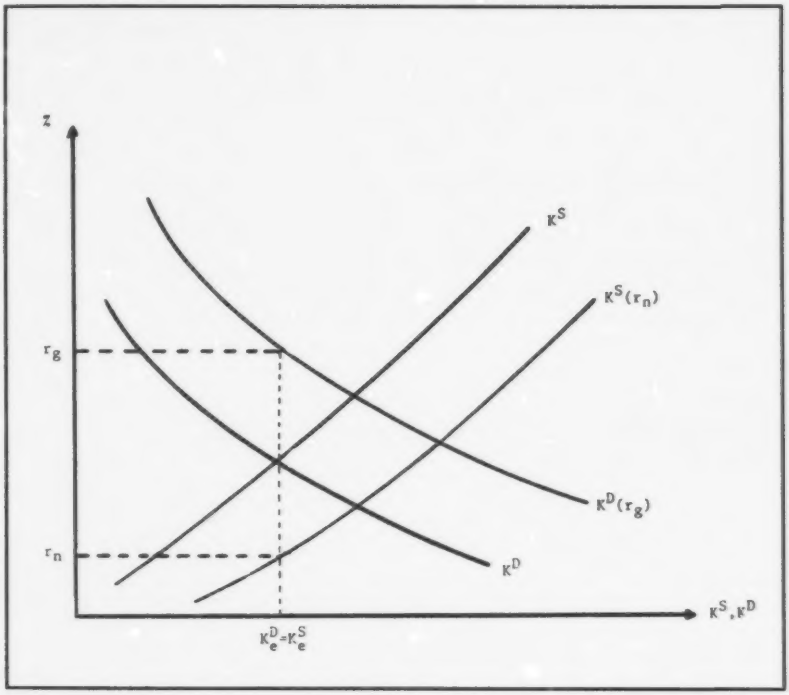

Figure 1. Closed Economy

the amount of capital demanded at the gross rate of return. In figure 1 this is represented by (K_e^D, K_e^S) which implies a gross rate of return of r_g and a net rate of return of r_n. The total (corporate and personal) effective tax rate in this economy is $t = (r_g - r_n) / r_n$. Of course, as discussed above, it is possible for the tax rate to be negative if the corporate write-offs are sufficiently generous so as to lower the gross rate of return below the net rate of return.

Figure 1 depicts a closed economy where the required rate of return on capital is determined endogenously by the domestic supply and demand for capital. This may not be a reasonable representation of the Canadian economy. Due to the free flow of capital between countries, the interest rate in Canada is largely determined on international financial markets and can essentially be treated as exogenous. The implications of this will be explored in more detail in chapter 4, but at this point it is important to note that the openness of Canadian capital markets effectively separates the investment from the savings side of the domestic economy. This is because the required after-tax rate of return on

capital is determined exogenously by the international capital market and is independent of what happens on the capital supply side. This is depicted in figure 2 where r is the internationally determined rate of interest. $K_e^D(r_g)$ and $K_e^S(r_n)$ again depict the demand for and supply of capital as a function of the gross and net rates of return respectively. With the interest rate determined exogenously, the demand for funds in Canada need no longer equal the domestic supply. Foreigners are able to make up any domestic short-fall of funds while a domestic excess may be invested elsewhere. Equilibrium may thus involve the stock of capital demanded domestically being either greater or less than the supply of domestic savings. The figure depicts Canada as a net demander of capital with the domestic demand for capital in excess of the supply of savings. The opposite case where Canadians are net suppliers of capital is easily illustrated.

In equilibrium, the supply of domestic and international funds for Canadian capital equals the domestic demand. This equilibrium is represented in the figure by (K_e^D, K_e^S), the gross rate of return r_g and the net rate of return r_n. The proportion of the capital stock financed by foreigners is $(K_e^D - K_e^S)/K_e^D$, and the total effective tax rate is $t = (r_g - r_n) / r_n$. The open economy assumption means that this tax rate may be disaggregated into that due to the corporate tax (income and mining taxes), $t_c = (r_g - r) / r$, and that due to the personal income tax on savings, $t_p = (r - r_n) / r_n$. In this way it is possible to isolate the impact of the tax systems and measure their distortions separately. As above, it should be noted that the marginal effective (corporate) tax rate on the firm may well be negative if corporate tax write-offs are generous enough (i.e., the present value of credits and write-offs exceed the purchase price of the asset).

In the remainder of this study, we focus on the distortion caused by the corporate income and mining taxes (t_c), ignoring, for the most part, personal taxes.[3] This may be justified on a number of grounds. First, we are primarily interested in the impact of the (diverse) corporate tax systems on investment in mining. The inclusion of the personal tax wedge may well mask important distortions on the corporate side. Second, if we assume that the supply of different types of saving is not capital-specific, then the personal income tax impinges upon all capital investments in the same manner. Third, as will be discussed in more detail in chapter 4, the separation between the investment and saving side of domestic capital markets implied by the open economy assumption means that the personal taxation of savings in Canada may have

3 In the example discussed above, the 10 percent hurdle rate is thus the before-personal-tax, after-corporate-tax required rate of return determined in international financial markets.

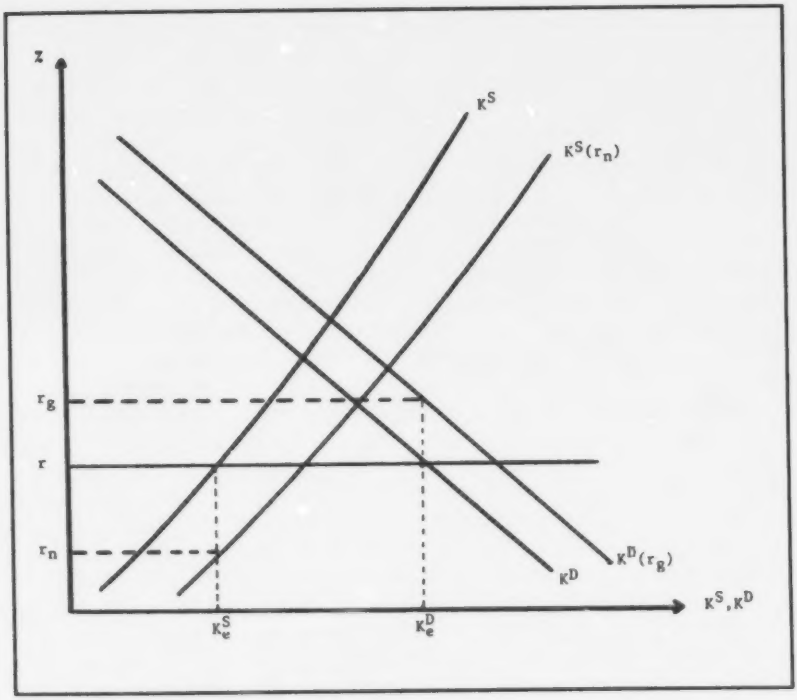

Figure 2. Open Economy

little effect on corporate investment as the required after-tax return on investment is determined exogenously. This means that the personal taxation of the return to saving influences the amount of investment financed domestically, but not the overall level of domestic investment. Nevertheless, in our analysis of flow-through shares, personal taxation is obviously important, as only domestic shareholders may hold flow-through shares.

The marginal effective tax rate is preferable to other measures of tax rates, particularly the average tax rate, for indicating the incentive effect of taxes. The latter is measured as taxes paid divided by the income earned by the firm. A number of studies that have assessed the impact of taxation on mining investment have used average tax rate calculations in the past.[4] These tax rates may give erroneous conclusions for two reasons.

The first reason is that the average tax rate applies to income generated by both marginal and inframarginal capital decisions. Firms that earn large rents

4 See for example, Energy, Mines and Resources (1982).

face high average tax rates compared to the tax payable for the marginal investment decision. For example, a pure rent tax that allows for the deductibility of imputed financing, depletion and depreciation costs does not yield positive tax revenues at the margin since income is just equal to capital costs. Nonetheless, for inframarginal investments, income is more than capital costs so positive tax revenues are paid. Thus, the average tax rate is positive and the marginal or effective tax rate is zero in this case. In general, firms that earn high rents tend to pay more tax per dollar of income than firms that earn no rent at all. Thus, average tax rates provide incorrect information regarding the impact of taxation on the investment decisions of firms since it is possible that firms could face the same tax at the margin but differ in terms of rents earned. Only the effective tax rate measured for marginal investments is indicative of how investment and expenditure decisions are influenced. Average tax rates are primarily helpful in measuring the total burden of taxes paid by the firm rather than the impact of taxation on economic decisions.

The second reason that average tax rates may be misleading has to do with the time profile of taxes paid by the firm. When firms start their capital projects, they earn little income and pay little taxes, or, perhaps, "negative" taxes, in the case where refundable investment tax credits exist. At a later time, income grows substantially and the firm begins paying taxes. In many studies, average tax rates are calculated by taking taxes paid divided by income earned in a given year. Since income and taxes both depend on the time profile of investment expenditures and the business cycle, the average tax rate measured on an annual basis varies over time. The marginal effective tax rate calculation is not sensitive to time since the calculations are based on the present-value criterion for evaluating investment projects. In principle, the effective tax rate is calculated by measuring the present value of taxes payable as a percentage of the present value of income earned on the marginal project, thereby avoiding mismeasurement related to the time.

Another method used to evaluate the impact of taxation on investment decisions of firms is project analysis.[5] The tax rate is measured by taking the present value of taxes paid and dividing it by the present value of income generated by a specific capital project. Income is estimated by using data for revenues and costs for a specific (often hypothetical) firm. In principle, project analysis and our effective tax rate measures are based on similar concepts since the time profile of taxes paid is taken into account in both methods. For the purpose of evaluating tax policy, however, project analysis suffers from several shortcomings. For instance, the typical investment project often generates rents, especially in the resource sector. Thus, the tax rate calculated for the investment project is similar to the average tax rate in that the tax on inframarginal returns

5 An application of project analysis applied to the pulp and paper industry may be found in F.J. Anderson, B.C. Boudreau and N.C. Bonsor (1983). See also Brian W. Mackenzie and Michel Bilodeau (1979).

is included in the tax rate measurement. Sometimes there is an attempt to measure income and costs for the marginal capital project that earns just enough income that its net present value (revenue less taxes and capital costs) is equal to zero. In this case, the tax rate roughly corresponds to the marginal or effective tax rate estimated in this monograph.

Another shortcoming of project analysis is that it is unable to distinguish among effective tax rates calculated for different forms of activities. This arises from the difficulty of imputing income accruing to specific capital expenditures that are incurred in the production process. An important advantage of the effective tax rate approach taken in this monograph is that we are able to measure specific tax rates for structures, machinery, depletion, processing, inventory and exploration and development. The reason for this is that we do not need to measure income earned by the firm; instead, we only measure the cost of capital, since it is equal to the rate of return to capital at the margin. This point is made clear in appendix A. Thus, in project analysis, only a single tax rate can be calculated for all investments and expenditures, while in our analysis, we calculate tax rates for different investment and expenditure decisions. It is for these reasons that government reports have now turned to the effective tax rate calculations that are similar to the ones we use here.[6]

As we point out above, the tax rate we calculate takes into account corporate income (both federal and provincial) and mining taxes. The reader should be aware that we do not include other taxes that may be paid by mining firms. These include personal income taxes, property taxes, and sales taxes on capital and business inputs. Thus, the effective tax rate that we calculate should not be viewed as the full tax distortion on the mining firms. Our estimated tax rate indicates only the influence of the corporate and mining taxes, leaving aside other taxes that might impinge on investment and financing decisions.

The economic variables that we need to measure in order to calculate marginal effective tax rates are the average debt-asset ratio, interest rates, the expected inflation rate, economic depreciation rates, and capital risk premiums. A more complete description of the data is contained in appendix B at the end of the study.

The estimates are based on 1987 values and assumed to be the same across all provinces and over time. The measure of economic depreciation varies across capital goods and is based on physical lives of goods. It is assumed that capital good prices rise with the general rate of inflation so that there are no real capital gains or losses on assets. The capital risk premium also varies by capital type: positive for depreciable capital, zero otherwise (such as the depletion decision, which is faced only with income risk due to uncertain mining ore revenues). Other economic variables, such as interest rates and the

6 See for example, the Economic Council of Canada (1987) and the White Paper on income tax reform released by the Department of Finance (1987).

debt-asset ratio, are assumed to be the same over time and across all firms, types of capital and provinces. Thus, in the absence of taxes, each type of capital and firm earn the same risk-adjusted marginal rate of return on capital.

The tax parameters are estimated using data taken from published sources, and in the case of CCA, the Tax Model of the Department of Finance. To estimate effective tax rates, we modeled the tax system of each province except for Prince Edward Island (which has negligible mining resources) and Alberta. In the case of the latter, the royalty system is based on the time taken to recover the cost of investment.[7] As for Saskatchewan, we modeled the potash and uranium tax regimes, which require additional data on the price-cost margins of firms; these data were obtained from the Government of Saskatchewan.

Our estimates of tax parameters generally vary across provinces, and in some cases, across different forms of activities. Statutory corporate and mining tax rates vary by province. The present value of tax benefits arising from CCA and investment tax credits vary across types of capital and, in a limited way, across provinces. To calculate the value of CCA, weights are first estimated to obtain an average CCA rate. These weights are based on additions to CCA classes (i.e., gross investment) that are available in aggregate, not province-specific, form. Having calculated the average CCA rate, we then estimated the present value of tax write-offs using the CCA rate, the combined federal and provincial statutory tax rates and the provisions of the provincial mining tax. Thus, the estimated tax value of CCA and investment tax credits under the corporate income tax vary across provinces only because provincial corporate statutory tax rates and mining tax provisions vary across provinces.

Capital stock weights, used to aggregate rates of return on capital to calculate the aggregate effective tax rate, are taken from two sources. The first is the distribution of gross investment across different types of capital. In principle, we prefer using the distribution of capital stock among structures and equipment but these data are not available. Instead, we use additions to CCA classes taken from Department of Finance data as a proxy for the distribution of capital. Since we assume that depreciation rates on buildings and equipment are the same (the average use of capital is during the mine's life estimated to be 20 years), gross investment weights serve as a good approximation. The second source of capital stock data is that used to estimate the aggregate effective tax rate on exploration and development. These data are based on the exploration and development expenditures for a typical mine in Canada (data made available from the Department of Finance).

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7 We have been able to develop a formula to estimate the effective tax rate on mining capital in Alberta. However, we are unable to undertake the calculations since the tax rate is contingent on the time taken to recover capital expenditures. These data are unavailable to us at this time.

EFFECTIVE TAX RATES ON MINING INVESTMENTS: THE BASE CASE

In this section, we examine the impact of taxation on investment decisions made by mining companies in eight provinces (excluding Alberta and Prince Edward Island). As mentioned above, for the base case, our calculations of effective tax rates are based on the assumption that the firm is fully taxpaying, both at present and in the future, and faces no risk or uncertainty; these assumptions will be modified below. Except for the corporate income tax provisions adopted in the 1986 federal Budget, we use 1987 tax law. Moreover, we assume that all capital investments are financed 60 percent by equity and 40 percent by debt. (We examine the implications of this assumption below when we consider different financing assumptions.)

Tables 11 and 12 present effective tax rate estimates for investment and expenditure decisions by type of capital and province. Using these tables we can discuss how corporate income and mining taxes distort economic decisions. The economic decisions of interest here are (i) the quantity of different factors, or inputs, to use in production (i.e., physical capital, exploration and development, inventories, etc.); (ii) the structure, or configuration, of production; and (iii) the location of capital investment.

The Input Decision

The "direction" of the impact of corporate income and mining taxes on input expenditure decisions (i.e., whether the taxes encourage or discourage the expenditure *vis-à-vis* the case where no taxes exist) is determined by the sign of the effective tax rate. If the effective tax rate is positive in value, the firm holds less capital or uses less of an input than it would in the absence of taxes. The converse holds if the effective tax rate is negative in value. A negative effective tax rate, which implies a subsidy, arises when the present value of the tax write-offs is more the economic cost of holding the capital or undertaking the expenditure. When the firm faces a negative effective tax rate, its marginal investment or expenditure is being subsidized, implying the firm is paying a negative tax at the margin. In this section, we assume that the firm is able to use marginal tax losses fully by writing them off against the tax liabilities generated by inframarginal investments. We can also think of this as the full loss offset case.

Table 11 presents combined federal and provincial effective corporate and mining tax rates for four broad categories of investments and expenditures: depreciable capital, exploration and development, depletable assets (after development), and inventory. As shown in the table, the tax system tends to subsidize expenditures and investments except in the case of inventories held after depletion but prior to sale. Inventories tend to be highly taxed because the firm is given inadequate tax write-offs under FIFO accounting in the presence

Table 11:
1987 Effective Corporate and Mining Tax Rates by Province and Broad Asset Categories: Fully Taxpaying Firms (percent)

Assets	Ontario	Quebec	British Columbia	Newfoundland	New Brunswick	Manitoba	Nova Scotia	Saskatchewan Uranium	Saskatchewan Potash	Total
Depreciable	-63.3	-78.3	-84.2	-78.7	-82.0	-97.1	-85.7	-2831.7	69.9	-126.4
Exploration and development	-31.2	-35.5	-44.0	-45.1	-45.4	-45.2	-44.4	-1617.0	-2.4	-56.2
Depletable	-40.3	-36.1	-49.8	-45.2	-44.4	-45.2	-44.4	-39.2	-34.4	-41.4
Inventory	61.2	41.9	49.3	47.7	53.6	54.0	47.9	720.5	435.5	84.3

Note: Companies are assumed to be taxpaying and to face "income" risk.

of inflation (see chapter 2). The tax rate on inventories is high relative to other industries because the mining firm must use first-in, first-out (FIFO) for both corporate income and mining tax purposes.

Other assets and inputs tend to be favoured by the corporate income and mining tax regimes. The holding of reserves available for extraction is favoured because the capital gain accruing to the firm in not extracting the ore is exempt from taxation. If the firm extracted its ore and invested the proceeds in bonds (or repurchased debt), it would pay tax on the income, earning a return equal to the net-of-corporate-tax return on debt. Since the capital gain on the unextracted reserves is not taxed, the tax system favours holding depletable assets rather than extracting them, especially if the firm's opportunity cost of finance is the net-of-tax cost of debt financing. Note that this latter incentive arises only with the corporate tax. The mining tax does not influence the depletion decision since interest is not deductible from the mining tax base.

Exploration and development is also favoured by the tax system, since the firm is able to expense all exploration and development costs immediately, as well as claim an additional earned depletion allowance against corporate taxable income. Moreover, exploration and development expenses do not reduce the value of the resource allowance under the corporate income tax. The firm is thus able to expense these costs at the full corporate tax rate even though the income generated by the exploration and development is taxed at the statutory rate net of the resource allowance. Exploration expenditures are also written off immediately in most mining tax regimes, and in some cases, are allowed a deduction similar to earned depletion (see chapter 2).

Investment in depreciable assets is also subsidized by the Canadian tax regime since the firm is able to write off mining investments at a faster rate than is warranted by economic depreciation. (The CCA rate for corporate income tax purposes and the depreciation rate used for mining tax purposes in many provinces is at least 30 percent; our estimate of the rate of economic depreciation for mine assets is somewhere in the neighborhood of 10 percent — see appendix B.) In the case of processing expenditures, firms are also able to claim a generous processing allowance under provincial mining taxes and earned depletion under the corporate income tax.

The most unusual case in table 11 is Saskatchewan, where the impact of taxes on investments in uranium and potash is especially perverse. Tax rates are either exceedingly high or low compared to other provinces; some explanation of these results is in order. The main source of the wide variation in Saskatchewan mining taxes arises from the tax provisions related to the graduated royalty used in calculating the uranium and potash taxes. The graduated tax on uranium is, in principle, a cash-flow tax (cash flow being revenues net of current and capital expenditures). However, the tax is calculated according to a schedule based on the rate of return earned on qualifying invested capital (the base is termed the capital recovery base, and includes depreciable assets and accumulated on-site

exploration and development expenses). As discussed in chapter 2, the top tax rate is 50 percent on income when the firm's rate of return to qualifying capital is more than 45 percent. The lowest rate is 0 percent which applies to the first 15 percent rate of return to capital. Intermediate tax rates are 15 percent on income earned when the rate of return is between 15 percent and 25 percent, and 25 percent when the rate of return is between 25 percent and 45 percent.

As a result of this graduated royalty, the firm is able to deduct capital expenditures up to three or four times.[8] The intuition underlying this is as follows. When a firm undertakes an investment, its capital base used for assessing the graduated royalty is widened, thereby affecting the rate at which income is taxed according to the graduated schedule. The firm writes off its marginal capital investment at the top rate that it faces but, by investing in more capital, marginal and inframarginal income is taxed at a lower "average" rate which is determined by the graduated rate schedule. For example, the first 15 percent rate of return is exempt from taxation. With this provision, capital is both expensed and given an additional deduction equal to 15 percent of capital in current and future years. In present-value terms, capital is expensed more than twice. This same logic applies to the intermediate income categories that allow income to be tax at a lower rate than the rate at which capital is deducted. Thus, in present-value terms, the Saskatchewan mining tax, graduated according to the rate of return to capital, affords a substantial benefit to the firm.

Those assets that do not qualify for the capital recovery base under the uranium tax (inventories and off-site exploration and development) can be highly taxed. This results from the high statutory tax rate imposed on the net revenues earned by the firm. At the top rate, the combined corporate income and mining statutory tax rates on Saskatchewan mining can be as high as 87 percent.[9] Since the assets are not expensed under the corporate income and mining tax, the effective tax rate can be very high, as in the case of inventories.

A similar result applies to potash which also uses a graduated royalty. The potash tax, however, is less generous than the uranium tax for two reasons. First, unlike the latter, the potash tax requires that capital be depreciated rather than expensed. Second, a substantial per-unit royalty tax is levied on potash firms that is, on average, 8 percent of the ore's selling price. (The tax is deductible from the provincial corporate income tax only.)

The Saskatchewan uranium and potash taxes also have some unusual incentives not found with other tax regimes. The most interesting is related to fluctuations in ore prices (see Mintz (1986). As a result of the graduated tax

8 See Mintz (1985) for a more complete explanation.

9 The combined rate is derived by adding up the federal tax rate net of the 25 percent resource allowance rate (27 percent) plus the provincial tax rate (17 percent) plus the mining tax rate taking into account deductibility from provincial corporate income taxes (50 percent X [1-.17] = 42.5 percent).

rate schedule, a mining firm faces high effective tax rates when mining prices are lowest, and low effective tax rates when prices are highest. This makes the Saskatchewan mining tax system countercyclical, in that investment is encouraged in a boom and discouraged in a recession.

The Choice of Production Structure

The impact of the tax system on the production structure of mining firms is best assessed by examining table 12, where effective tax rates are presented on a more disaggregated basis. One would expect the tax system to be especially distortionary when highly taxed activities can be easily replaced by other tax-favoured activities in the production process.

The corporate and mining tax systems in most provinces are particularly favourable to the following activities: (i) new mine investments or large-scale mine expansion, (ii) processing, and (iii) pre-production exploration and development. Acquisition of property rights and the holding of inventories are especially highly taxed. This all suggests that mining firms are encouraged to undertake development before, rather than during, production, and to process mining ore before export. Mining firms are also provided with incentives to undertake large- rather than small-scale expansions. For example, there may be a tendency for small-scale expansions to be deferred until the expansions qualify for new mine asset CCA treatment (class 28) and earned depletion.

Some of the generosity of the tax system for certain activities might arise from tax competition among provinces and with foreign countries. In particular, provincial mining taxes give substantial write-offs for processing. If any one province eliminates its subsidy, it fears that it could lose mining processing facilities to other provinces or foreign jurisdictions.

The Location Decision

The other distorting effect of the mining tax regime in Canada is with respect to the location of capital investments across provinces. Capital location depends on after-tax profitability; those jurisdictions with the lowest tax rates will be most attractive to the mining firm.

The numbers presented in tables 11 and 12 suggest that effective tax rates vary substantially across provinces, thereby possibly distorting the location of investment. The main source of this variation lies with provincial mining tax systems and rates of provincial corporate income tax. The latter varies from 5.5 percent in Quebec to 16 percent in British Columbia, Newfoundland and Manitoba.

The most pronounced differences in effective tax rates across provinces arise in the cases of depreciable assets and exploration and development. Not only do mining and provincial corporate income tax rates differ, but so do the tax write-offs allowed for capital investments in machinery and structures. The

Table 12:
1987 Effective Corporate and Mining Tax Rates by Province (percent)

	Ontario	Quebec	British Columbia	New-foundland	New Brunswick	Manitoba	Nova Scotia	Saskatchewan Uranium	Saskatchewan Potash	Saskatchewan Total
Depreciable Assets										
Mining assets	-24.2	-32.4	-26.3	-24.3	-26.8	-24.8	-32.7	-2865.9	183.7	-76.4
New mine assets										
Basic	-74.5	-83.6	-101.6	-95.2	-98.6	-119.7	-101.7	-2808.4	37.4	-138.8
Accelerated	-111.9	-110.5	-144.0	-129.7	-132.9	-162.9	135.8	-2930.3	-57.4	-179.0
Processing assets	-76.9	-94.9	-164.6	-98.0	-101.5	-122.6	-104.5	-2818.1	29.8	-144.0
Weighted total	-63.3	-78.3	-84.2	-78.7	-82.0	-97.1	-85.7	-2831.7	69.9	-126.4
Exploration and Development										
Grass roots exp.	-37.7	-42.2	-52.9	-55.7	-56.8	-55.5	-52.6	-1167.2	-29.2	-67.7
Pre-prod. dev.	-37.7	-42.0	-52.8	-50.8	-51.7	-52.3	-52.6	-1167.2	-29.2	-67.2
Post-prod. dev.	0.0	-3.4	0.0	2.9	2.8	3.2	0.8	-1039.8	69.9	-18.7
Property rights	9.7	5.5	10.6	3.4	8.5	6.8	4.9	274.9	191.6	22.5
Weighted total-	31.2	35.5	-44.0	-45.1	-45.4	-45.2	-44.4	-1017.0	-2.4	-56.2
Depletable assets	-40.3	-36.1	-49.8	-45.2	-44.4	-45.2	-44.4	-39.2	-34.4	-41.4
Inventories	61.2	41.9	49.3	47.7	53.6	54.0	47.9	720.5	435.5	84.3

Note: Companies are assumed to be fully taxpaying and facing "income" risk.

most obvious case is Saskatchewan which we have already discussed at length, but other examples can be cited. For example, Ontario and Quebec allow depreciable assets to be written off at a faster rate (30 percent straightline) compared to other assets. Quebec, British Columbia, and New Brunswick give earned depletion for qualifying capital expenditures while other provinces do not; this is especially important for exploration and development expenditures.

Leaving aside Saskatchewan, we see that Nova Scotia and British Columbia provide the highest subsidy rates for depreciable assets. Incentives for exploration and development are somewhat lower in Ontario and Quebec. Differences in tax rates on depletable assets are small except for Quebec which has a low corporate tax rate. The tax on inventories is especially high in Ontario.

It is worth noting that the above assessment of effective tax rates on the location of capital only applies to corporate income and mining tax regimes. Other taxes, such as provincial capital levies, sales taxes and property taxes, may offset any incentives provided by provinces through their corporate income and mining tax regimes.

SPECIAL CASES

In this section, we consider alternative assumptions that may be used in estimating effective tax rates. In this way, we can determine to what extent the conclusions found in Section II are affected by limitations in our analysis. In particular, we wish to see if we overstated the extent to which corporate and mining tax regimes have subsidized mining investment expenditures. The assumptions that we will consider are the following: (i) different forms of risk, (ii) tax losses, (iii) different methods of finance, and (iv) alternative modelling of exploration and development.

Impact of Taxes on Risky Mining Investments

To this point we have ignored the issue of how the tax system may influence the level of risktaking by mining firms. In order to incorporate uncertainty into the analysis it is necessary to define the concept of risk carefully. It has become common in the economics literature to distinguish between at least two types of uncertainty which a firm may face. The first is known as *income risk*. This involves uncertainty regarding future income or revenues. For mining firms, the uncertainty may be caused by fluctuations in ore prices resulting from world events that are exogenous to the actions of the producers.

The second type of uncertainty is known as *capital risk*. It involves uncertainty regarding the economic rate of depreciation of capital. Since economic depreciation is equal to replacement-cost depreciation less the capital gains earned in holding assets (see chapter 2), capital risk can arise from two sources. The first is uncertainty regarding the economic life of the assets. Equipment and other capital goods may be of either good or bad quality; the quality of the

capital good is not typically known beforehand. The second source of capital risk is uncertainty regarding the price of capital goods in the future. The price at which capital goods may be sold or purchased for replacement depends on demand and supply conditions which can be uncertain at the time an investment decision is made, due to factors such as obsolesence.

There are other types of risk that will not be considered here. For example, the firm may be uncertain about future interest rates, inflation, or even tax parameters. These types of uncertainty will be ignored.

The way in which we incorporate risk into our analysis is to assume that owners of capital must be somehow compensated for incurring risks. This compensation takes the form of an expected rate of return higher than the risk-free rate. For example, risk-averse investors may be indifferent between holding an asset with a certain return of 10 percent and an asset with an uncertain expected return of 12 percent. The 2-percentage-point difference between the required return on the risky asset and the riskless rate of return is known as the *risk premium*. The risk premium can be thought of as representing the opportunity cost of bearing risk. To the extent that a tax system impinges upon this excess return, it may influence the firm's decision to undertake risky expenditures. In order to determine the impact of taxes on risktaking, it is necessary to specify what form the uncertainty takes: i.e., is it due to income risk or capital risk?

There are important differences in calculating effective tax rates for each type of risk. Consider income risk first. In this case, the firm faces uncertainty regarding its future income or revenues. As is shown formally in appendix A, under full refundability of tax losses (full loss offset) the tax system allows for the full and immediate deduction of the opportunity cost of risk, and therefore does not impinge upon the risk premium. This means that the tax system does not affect the incentive to invest in income-risky assets *vis-à-vis* riskless assets. In the case of income risk, a fully taxpaying company is thus able to deduct in full the cost of risk from its taxable income. This deduction is "implicit" rather than "explicit", in the sense that there is no outright deduction given for risk. Instead, the cost of risk is deductible because the government shares the variability of income by providing full refundability of tax losses (at the full corporate tax rate). A full loss offset treats gains and losses in income equivalently — the firm is able to receive a (refundable) tax credit equal to the loss times the tax rate. For a taxpaying company, this implies that losses generated by marginal investments are fully deducted against income generated by inframarginal investments. Mintz (1988) found that one-half of investment in the resource industry was undertaken by firms that paid corporate income taxes during the years 1979-81. Thus, any income risk faced by these taxpaying firms was fully shared by the government. For tax loss companies, however, tax losses are not fully deductible; this case is discussed in the following section.

What does all of this mean for the effective tax rate estimates discussed above? The implication of the full implicit deduction of income risk in the case of the fully taxpaying firm (or a full loss offset tax system) is that the tax rates discussed in the base case of this chapter, where risk was essentially ignored, are unchanged by the introduction of income risk: riskless and income-risky investments face the same effective tax rates under full loss offset.

Such is not the case for capital risk. Recall that with capital risk the future replacement price of capital and/or the physical rate of depreciation are unknown. With capital risk, even if the tax system allows full loss offset, the appropriate opportunity cost of bearing the risk is not appropriately deducted, and taxes can have an additional influence upon the incentive to undertake capital-risky expenditures (*vis-à-vis* riskless expenditures). This is because depreciation allowances for tax purposes (CCA) are determined on an *ex ante* basis, based upon the original purchase price of the asset, not on its actual replacement cost. This means that if economic depreciation were higher (lower) than anticipated, the tax system would not allow a higher (lower) depreciation claim. Tax depreciation granted on the basis of the original purchase price of the asset does not allow for the appropriate deduction of capital risk, as the replacement cost of capital is not reflected in the valuation of CCA used for tax purposes. Capital risk is only shared to the extent that government assists the firm in sharing the cost of asset acquisition; namely, through ITCs and the tax value of earned depletion, processing allowances and CCAs. Thus, in the case of capital risk, taxation does tend to impinge upon the risk premium even in the case of full taxability or full loss offset.

From the above discussion, one might expect that the Canadian tax system discourages investment in assets which face capital risk. The impact of the current tax system on capital risk is in fact ambiguous. If the tax value of capital write-offs per dollar of the asset is less than the statutory tax rate, capital risk is penalized by the tax system, since the present value of risk-adjusted income generated by capital is taxed more highly than the present value of capital cost write-offs. The converse can also hold: capital risk can be subsidized if the tax value of write-offs is more than the present value of taxes imposed on the income generated by the asset.[10]

Table 13 presents effective tax rates on capital taking into account the two cases of income and capital risk. As discussed above, the effective tax rates for income risk are the same as for riskless assets held by a taxpaying company (or under a full loss offset). For the case of capital risk, a risk premium is measured which takes into account fluctuations in capital good prices. Capital risk is difficult to estimate since we have no data on specific capital good prices that can be used to measure a risk premium. Instead, we use an argument put forth by Bulow and Summers (1984) that the market value of the firm is equal to the

10 This point is made clear in a more formal manner in appendix A.

Table 13:
1987 Effective Tax Rates on Mining Capital in the Presence of Income and Capital Risk Depreciable Assets Only (percent)

	Ontario	Quebec	British Columbia	Newfoundland	New Brunswick	Manitoba	Nova Scotia	Saskatchewan Uranium	Saskatchewan Potash	Total
Mine Assets										
Income	-24.2	-32.4	-26.3	-24.3	-26.8	-24.8	-32.7	-2865.9	183.7	-76.4
Capital	-18.7	-31.2	-18.2	-17.2	-20.8	-17.8	-28.8	-3820.4	259.9	-88.0
New Mine Assets										
Basic										
Income	-74.5	-83.6	-101.6	-95.2	-98.6	-119.7	-101.7	-2808.4	37.4	-138.8
Capital	-138.0	-137.2	-180.4	-161.1	-165.8	-206.6	-169.7	-3990.2	-63.2	-229.4
Processing										
Income	-76.9	-94.9	-104.6	-98.0	-101.5	-122.6	-104.5	-2818.1	-29.8	-144.0
Capital	-90.3	-116.0	-125.3	-117.6	-122.6	-151.4	-126.8	-3836.9	56.1	-181.6
Total										
Income	-63.3	-78.3	-84.2	-78.7	-82.0	-97.1	-85.7	-2813.7	69.9	-126.4
Capital	-71.8	-93.4	-97.4	-91.4	-96.0	-116.5	-101.2	-3833.8	109.1	-157.1

replacement cost of its capital: any stochastic variation in replacement cost is reflected in the market value of the firm. The estimate of capital risk is thus based on the covariation of an industry's net-of-corporate tax rates of return to equity and bond assets with that of the whole market. With this methodology, we had no asset-specific or province-specific estimate of capital risk since we could only use stock market statistics available for Canadian mining firms in general. We did assume, however, that capital risk only applies to structures and machinery. Exploration and development expenditures and depletable assets are assumed to face only income risk since the uncertainty is related to ore revenues.

The impact of corporate and mining taxes on risky investments varies considerably across the two types of risk. In the case of mine assets, effective tax rates are generally higher (less negative) with capital risk compared to income risk. For new mine and processing assets, the opposite is generally true (the exception being Saskatchewan potash). These observations can be explained by the comments made above with respect to capital risk. When firms are able to enjoy fast write-offs for capital, it is quite possible that capital risk is subsidized by the government. This arises in the case of new mine and processing assets since, in addition to capital cost allowances, earned depletion, investment tax credits and processing allowances dramatically reduce the firm's net-of-tax purchase cost of assets.

In general, we find that corporate and mining tax systems in Canada tend to subsidize capital risk (compare the last two rows of table 13). The only exception is Saskatchewan potash where tax write-offs for depreciable capital are not as generous in reducing the impact of capital risk on the potash firm. We would thus conclude from table 13 that the pre-reform tax system has encouraged risktaking by mining firms. The impact of the corporate and mining tax on risktaking allowing for the federal corporate tax reform is discussed below.

Effective Tax Rates on Tax Loss Companies

The above calculations were based on the assumption of full loss offsetting. For taxpaying companies, this is a reasonable assumption. For firms that experience tax losses from time to time, the assumption of full loss offsetting is not appropriate. A firm may be non-taxable, for example, due to large banks of past tax losses. In this case, the income (write-offs) generated by the marginal investment may not be taxed (deducted) until some later point in time. Alternatively, a young firm may be making its initial investment, which earns income only at some later point in time. In this case, credits and deductions cannot be written off against income generated from past investments and must be postponed.

Loss offsetting is imperfect in Canada because the firm is not able to write off its tax losses fully from (i) current income (since limits exist on the transfer

of losses from tax loss to taxpaying companies), (ii) past income (due to limitations on the carryback of losses) and (iii) future income (since losses are not carried forward indefinitely at a rate of interest). Imperfect loss offsetting is especially important in the case of the mining industry, where junior and some larger companies often experience tax losses during the history of their investments.

The lack of full loss offsetting influences the investment decision in at least three important ways. The first is that losses shelter from taxation income generated by marginal investments; otherwise, the assets would be taxed (as in some of the cases shown in the previous section). Thus, tax loss firms could enjoy lower effective tax rates than taxpaying ones.

The second way in which lack of a full loss offset influences effective tax rates is that marginal investments are prevented from benefiting from various write-offs and credits allowed under the tax system. Instead, the firm can only use the write-offs in the future; the tax value is less than the current value, since the loss is not carried forward at a rate of interest. Thus ITCs may not be claimed as soon as they are earned and the statutory ITC rate is in effect reduced by a present value factor. The present value of CCA, CDE and CEE claims must also be reduced by a similar present value factor. Also, the cost of finance increases as the deductibility of interest for income tax purposes is postponed. The lack of ability to use tax write-offs immediately can thus penalize tax loss firms relative to taxpaying companies and raise the marginal effective tax rate.

The third impact of tax losses is that firms facing income risk cannot fully deduct losses from taxable income (recall that the assumption of full loss offsetting was very important to the estimates discussed in the previous section). Since the government shares losses imperfectly, the income-risky firm is penalized by the absence of full loss offsetting. This could put tax loss firms at a disadvantage compared to taxpaying ones.

From these three effects it is evident that it is not possible to determine *a priori* whether imperfect loss offsetting increases or decreases the effective tax rates on capital and expenditures. Firms in a loss position may be either better or worse off than fully taxpaying firms. Aside from the factors discussed in the fully taxpaying case, the impact of the tax system in the case of a tax loss firm depends critically upon the time profile of the tax status of the firm.

To analyze the impact of taxation in the case of firms which are not fully taxpaying in an analytically (and empirically) tractable fashion, it is necessary to make some very specific assumptions about the time profile of tax loss claims. In this regard, we follow the methodology of and use the data reported by Mintz (1988).

In our calculations, we take into account three cases. As a basis of comparison, the first case is a firm that can fully use tax losses by carrying back any losses against past profits to claim a refund. Given the limitation in carryback

provisons, this implies that tax losses are relatively small. This case is identical to the full taxpaying company discussed in the previous sections.

In the second case, we assume that the firm is currently non-taxpaying in the sense that the firm already has accumulated tax losses from the past or knows that income generated by capital investments will not be earned until sometime later. This implies that, when new investments are undertaken, the taxable income that is generated becomes taxable only at a later time. On the other hand, if the taxable income generated by a new investment is negative (due to fast write-offs), the tax value of marginal losses is reduced since the loss write-off is postponed to a later time. In this second case, we also assume that the firm knows how long it takes to write off tax losses. It calculates the present value of taxes payable on income by discounting the value of taxes owing at a later time when the firm becomes a taxpaying one (or if there are tax losses, the tax benefit of write-offs is the amount of tax saved in the future, discounted to the present). This assumes the firm is certain about the time taken to write off losses.

The third case is the "start-up" firm. It has no or few accumulated tax losses to shelter income from taxation. Moreover, investment is highly risky. That is, the firm may be fully taxable immediately or not taxable until sometime later (because of uncertain revenues). Thus, the firm is uncertain about its tax status and the time taken to write off losses. We should point out this type of risky firm need not be one just starting up. It could also be one that jumps between taxpaying and non-taxpaying status over time. The point is that the investment faces a risky income stream and has no accumulated tax losses to affect current investment decisions.

It should be stressed that these cases are illustrative only and by no means exhaust all of the possibilities. Indeed, each tax loss case is unique, depending upon the time profile of the firm's expected cash flow. We present these cases primarily for illustrative purposes, in order to show how imperfect loss offsetting can influence the impact of taxation upon the investment decision.

In the effective tax rate estimates presented in this section, we specifically ignore tax provisions that allow for the flowing out of tax write-offs to other firms or shareholders (such as through limited partnerships flow-through shares, which are dealt with separately below). In estimating the tax loss parameters necessary to compute effective tax rates for the cases discussed above, we make use of tax loss utilization data obtained for the resource industry as whole. Realistically, effective tax rates can vary from company to company. The rate of tax depends on a company's ability to use losses over time. This, in turn, depends on many factors such as the degree to which debt is used as a source of finance (since interest deductions add to tax losses) and uncertainty in income (firms with more certain income face a lower probability of incurring tax losses). Since we did not have individual firm data, we could measure only effective tax rates based on the average loss experience of the

industry. Our calculations are also based on the assumption that the firm faces only income risk, not capital risk. We also had data for corporate tax losses only, not mining losses. The use of corporate tax losses is estimated as the percentage of losses written off each year as a proportion of total tax losses and unused deductions of the industry averaged for the years 1977-82 (see the appendix B for futher discussion). These data were used to estimate the time taken to write off a marginal tax loss.

In Table 14, we present effective tax rates for each of the three cases discussed above. As shown in the table, the presence of tax losses has an ambiguous impact on the effective tax rate faced by the firm. If the marginal investment generates taxable income, the effective tax rate faced by a currently non-taxpaying company is less than that faced by the taxpaying firm. This is well illustrated by inventory capital. Investment in inventories by a tax loss company allows the firm to use up past tax losses that shelter inventory capital from taxation.

Table 14:
1987 Effective Tax Rates on Mining Capital for Taxpaying and Non-taxpaying Companies — Aggregated for all Provinces (percent)

		Non-taxpaying	
Assets	Taxpaying	Currently Non-taxpaying	Start-up
Depreciable	-16.4	-58.7	39.4
Exploration and Development	-56.2	-11.2	-48.5
Depletable	-41.4	-10.5	124.4
Inventory	84.3	32.6	250.0

Those assets that are written off quickly can be more highly taxed in the hands of a tax loss firm compared to a taxpaying one. For depreciable assets (mining, new mine and processing assets), exploration and development and depletable assets, effective tax rates are less negative for tax loss compared to taxpaying companies. This is especially so for start-up risky investments which are also penalized by imperfect loss offsetting in the tax system. In fact, effective tax rates for "start-up" firms can be positive rather than negative, as illustrated in table 14.

Although the above calculations consider only three particular examples of tax loss utilization, there is substantial variation in effective tax rates across firms of different tax status. This suggests that the corporate and mining tax systems can be highly distortive. The numbers presented in table 14 mask considerable variation in effective tax rates across firms with different tax histories that we could potentially use for our estimates. Despite this, the

numbers do suggest that tax losses create substantial cross-variation in effective tax rates across firms. This leads to significant distortions in the allocation of capital in the mining industry.

Financing and Effective Tax Rates

Our estimates of effective tax rates have been based so far on the assumption that 60 percent of capital is financed by equity and 40 percent by debt. In this section, we consider how alternative assumptions about the way in which capital is financed affect our conclusions regarding the impact of taxation on investment. This is particularly important since mining firms have recently relied heavily on the use of equity capital in the form of flow-through shares to finance exploration and development.

We begin our analysis by looking at the impact of different degrees of leverage (the debt-equity ratio) on effective tax rates. Effective tax rates tend to be lower in value when firms finance capital with more debt. There are two reasons for this. First, interest is deductible from corporate taxable income. Firms that use more debt are able to avoid corporate taxes that would otherwise reduce the income accruing to the equity owners. Second, firms are able to deduct interest unadjusted for inflation. Since, in times of inflation, part of the interest payment is meant to maintain the purchasing power of the debt's principal held by the lender, a deduction of interest unadjusted for inflation allows some of the real value of debt to be deducted from the tax base — in effect, a portion of the principal is deducted.

In table 15, we show the impact of leverage on 1987 effective corporate tax rates, aggregated for all provinces. As shown in the table, taxpaying firms that finance their investments by 40 percent debt (60 percent equity) enjoy much lower effective tax rates compared to firms that are all equity-financed. In fact, interest deductibility in itself leads to a distortion; firms are encouraged to use debt compared to equity in the presence of the corporate tax.

The beneficial effects of the deductibility of debt interest payments for corporate tax purposes can be offset by personal taxes, which are generally higher on interest than on capital gains or dividends. However, the level of personal taxation varies across individuals of different income classes and countries, so the overall impact of corporate and personal taxes depends on the income and residence of the marginal investor that provides financing to capital markets. For example, a high-income individual in a country with low capital gains taxes (i.e., Canada and the United States prior to their recent tax reforms) would prefer a Canadian firm to finance its capital by equity, since the combined corporate and personal tax on equity is less than that on debt. On the other hand, a low-income individual would prefer the firm to use debt. How these personal tax differences get sorted out depends on the way financial markets operate. Some models suggest that firms issue debt, trading off tax benefits with the cost of additional leverage (such as bankruptcy). Once adjusting for these taxes and

Table 15:
Effective Tax Rates for Various Financing Options — Aggregated for All Industries (percent)

	Corporate Tax Rates Only		*Corporate and Personal*		
Assets	60% Equity	All Equity	Retentions	New Equity	Flow -Through Shares
Depreciable - Taxpaying firms	-126.4	-81.5	-	-	-
Depletable - Taxpaying firms	-41.4	0.1	-	-	-
Inventory - Taxpaying firms	84.3	172.4	-	-	-
Exploration and development					
- Taxpaying firms	-56.2	-53.2	-33.2	48.9	-21.0
- Non-taxpaying firms	-11.2	-2.2	-5.5	51.5	-45.2

costs, as well as for risk, all investors earn the same rate of return on assets. In these models, however, corporate tax deductibility of interest is not fully offset by differences in the tax treatment of bond and equity income at the personal level, so that taxes in general favour debt finance.[11]

The interaction between personal and corporate taxes on capital investments is especially important with respect to the financing of exploration and development by mining firms. As pointed out in chapter 2, a mining company can finance exploration and development either by using conventional sources of finance or by issuing flow-through shares. With the latter, the company sells new equity to investors to finance exploration and development and renounces its corporate tax deductions (CEE, CDE and earned depletion) to the investors, who claim the tax write-offs to reduce their personal tax liability. Prior to tax reform, the investor who purchased the equity could deduct up to 133 percent of the value of equity from personal income. The purchase cost of the equity share is adjusted to zero for the purpose of calculating the capital gains tax. The latter is paid on half the gain realized when the investor sells his flow-through equity share. The share must also be held for at least one year to be eligible for flow-through treatment. Until the recent tax reform, the capital gain earned on the flow-through share was fully eligible for the life-time capital gains exemption. As discussed in chapter 2, after tax reform this will no longer be the case, as the amount of the gain eligible for the exemption is reduced by half of any deductions taken in respect of the flow-through shares.

The basic principle of flow-through shares is to allow a tax loss firm to use its corporate tax write-offs that would otherwise be carried forward to the future. Thus, one would expect that it would be primarily tax loss firms that would use flow-through-share financing techniques. However, given the design of the flow-through share mechanism, there could be a tax advantage to a taxpaying firm to finance exploration and development with flow-through shares since personal tax rates are not equal to the corporate tax rate of the mining firm.

The consequences of flow-through-share financing upon the incentive to undertake exploration and development expenditures may not be completely obvious. It is thus useful to outline in a general way the various tax consequences of flow-through share financing, and the way in which they may influence the firm's expenditure decisions.

There are three different ways in which the use of flow-through-share financing has tax implications for the exploration and development decisions of mining firms. First, the renouncing of the tax deductions for exploration and development (and, where applicable, earned depletion) to the shareholders means that the tax saving takes place at the personal tax rate rather than the

11 For a detailed discussion of these models, see J. Bartholdy, G. Fisher and J. Mintz (1987). The authors found that each point increase in the corporate tax rate led to a three-quarter-point increase in the leverage ratio of the firm.

corporate tax rate. Whether or not this is beneficial depends upon the relationship between the shareholder's personal tax rate and that of the corporation. We would generally expect it to be advantageous, expecially for high-income shareholders, since the firms using flow-through-share financing will typically be in a non-taxpaying position so their "effective" statutory corporate tax rate will generally be quite low. Of course, if we are comparing flow-through-share financing with full refundability, the applicable corporate rate will be the full statutory rate and the relative benefit of flow-through-share financing will be much less (and perhaps negative). Note that we are assuming here that flow-through shares are "correctly" priced in the market in that they fully and accurately reflect the special tax status of the shares. Recent anecdotal evidence suggests that this might not in fact be the case.

Second, setting the adjusted cost base to zero for capital gains tax purposes imposes an additional tax liability on flow-through shareholders relative to ordinary shareholders. For example, if the selling price of an ordinary share is p, once the flow-through share is issued and the deductions renounced, all else being equal, the share price of the flow-through share should also be p. The rules that set the adjusted cost base of flow-through shares to zero mean that shareholders are liable to pay additional capital gains taxes on the price p over and above what ordinary shares would be liable to pay. This would tend to lower the price of the flow-through shares *vis-à-vis* ordinary shares. This effect may have been minimal prior to the 1987 White Paper on tax reform, due to the generous lifetime capital gains exemption. However, the reduction in the capital gains exemption limit from $500,000 to $100,000 and the introduction of the cumulative net investment loss (CNIL) rules proposed in the tax reform package are likely to change this. Recall that these rules call for a reduction in the amount of a taxable capital gain eligible for the exemption by any deductions claimed in respect of the shares. This clearly limits the availability of the capital gains exemption for flow-through shareholders.

The third tax implication of flow-through shares is that they involve financing exploration and development by new share issue. It is well established in the economics literature that, as long as the capital gains tax rate is less than the personal tax rate on dividends, there is a tax disadvantage to using new issues of shares for financing, rather than, say, debt or retained earnings. As with the second influence discussed above, this factor tends to reduce the tax advantage of flow-through-share financing.

A more formal treatment of flow-through shares is undertaken in appendix A. However, from the above discussion it is evident that the impact of flow-through-share financing on the incentive to invest is ambiguous, and depends upon the value of the tax parameters.

In the last three columns of table 15, we show effective tax rates for exploration and development investments made by taxpaying and currently non-taxpaying companies under flow-through shares, new equity and retained

earnings financing. The effective tax rates that are reported in these columns are combined corporate and personal tax rates, assuming that the investor is a Canadian in the top income bracket. This assumption is contrary to the one we generally use, namely, that marginal sources of financing comes from the international market. Thus, the effective corporate and personal tax rates calculated for retentions and new equity issues in table 15 are based on a Canadian investor providing the marginal source of finance, rather than an international investor. It is likely that flow-through shares are purchased only by Canadians (who enjoy the tax advantages) while other equity is derived from the international market. Thus, the markets are "segmented" in the sense that personal tax rates of upper-income Canadian investors are relevant to the pricing of flow-through shares while foreign personal tax rates are relevant to the pricing of conventional share issues.

Table 15 indicates that retentions are the favoured source of finance for taxpaying companies and flow-through shares are most favoured source for non-taxpaying firms. The tax system heavily discriminates against new equity issues for both taxpaying and non-taxpaying firms.[12]

Flow-through shares thus have a dramatic effect on effective tax rates for exploration and development undertaken by tax loss firms. Many of these firms are junior companies that have engaged in limited partnerships with larger companies when issuing the flow-through share. In this way, the share may be more creditable to investors who are concerned about recovering their investment when they sell the shares at a later time. To attract larger firms in the deal, the small firms may have to pay compensation to the larger company that engages in the limited partnership. The numbers in table 15 suggest that if the compensation is paid to a large taxpaying firm, it offsets the additional tax cost borne by the taxpaying firm that would prefer using conventional sources of finance for exploration and development.

Recent tax reforms at the federal level have important impacts on financing choices, especially with respect to flow-through-share financing. We discuss these impacts later in this chapter.

Modeling Exploration and Development

The final special case that we consider takes an alternative view regarding the process used by firms to discover and develop ore bodies. The theory underlying the effective tax rate estimates presented above (see appendix A) assumed that intangible exploration and development expenditures (on labour, leased capital, etc.) undertaken in a period immediately led to an increase in the amount of reserves available for extraction. This is referred to as a *point-input, point-out-*

12 The effective tax rates for exploration financed by flow-through shares, retentions or new equity reported in table 15 are calculated under the assumption that the effective accrual capital gains tax rate is zero. This amounts to assuming that the marginal investor has not exhausted his capital gains exemption.

put production process. It implies that exploration and development expenditures are in the nature of a current input, like labour, not a capital input like land or physical capital.

In actual fact, the exploration and development process is not so simple to characterize. Firms use labour and leased capital to find and develop orebodies, but it may take time to do so. The process itself is more in the nature of a "time to build" problem, in that expenditures on exploration and development are incurred until the "capital", which is knowledge about the reserve, is finally discovered. Thus, instead of the point-input point-out process that we have used so far, the exploration and development process can be characterized as *flow-input, point-output* problem.

What implication does this have for our effective tax rate measures? Since we have no data regarding the time taken to find discoveries, we can only discuss the qualitative impact of this alternative view of the exploration and development process on effective tax rate measures. In particular, the important point to bear in mind is that there is lag between expenditures on exploration and development and "income" earned when resources are discovered or extracted at a later time. Because of this lag, there can be a tax benefit to the firm arising from the mismatching of income and expenses. The value of the tax benefit is related to the deductibility of interest from the corporate income tax base — a firm that finances its exploration and development expenditures with debt is able to write off interest expenses from other sources of income. Since exploration and development expenditures are already expensed, the firm is able to enjoy an additional deduction related to the expensing of financing charges. If such interest were not deductible, there would be no additional tax benefit to a firm that discovers orebodies with a lag compared to one that faces no lag at all.

The above implies that incorporating a lag between exploration and development and discovery tends to reduce effective tax rates below those reported above, to the extent that the firm uses debt to finance such expenditures. This suggests that mining tax effective tax rates would not be affected by the mismatching of income and expenses since interest is not deductible. On the other hand, effective corporate income tax rates would be lower as a result of interest deductibility. Taxpaying companies would especially enjoy a lower effective tax rate on exploration and development compared to those calculated in the various tables. Tax loss firms that have difficulty in using interest deductions would not gain much tax benefit from the mismatching of income and expenditures.

THE IMPACT OF CORPORATE TAX REFORM ON MINING INVESTMENTS

The estimates presented in the previous sections were based on the corporate tax law that existed prior to tax reform in Canada. As discussed in chapter 2, in February 1986 the federal government announced the first phase of corporate tax reform which included:

- the elimination of the general investment tax credit (ITC), phased in over a three-year period;
- the elimination of the inventory allowance;
- a reduction in the federal statutory corporate tax rates (for example, three points for large mining firms phased in over three years).

In June 1987, the second phase of corporate tax reform measures was proposed. For mining firms the most important of these included:

- a reduction in CCA rates so that most assets can no longer be written off at a rate of more than 30 percent;
- a further reduction in federal statutory corporate tax rates (except for small manufacturing);
- the elimination of earned depletion;
- put-in-use rules that allow capital to be depreciated only after production takes place;
- capitalization of transaction costs incurred by issuing new equity;
- a new tax on term preferred dividends received by financial firms (this particularly affects financing of manufacturing and resource companies);
- introduction of cumulative net investment loss (CNIL) rules for the capital gains exemption (which has important implications for flow-through shares).

The most important of these tax changes that affect mining investments are those related to CCA write-offs, the ITC, the inventory allowance, earned depletion, flow-through shares and statutory corporate tax rates (see chapter 2 for more specific details on the tax changes). In this section, we reassess our effective tax rate measures taking into account only these federal corporate tax reform measures. Since the measures were introduced in 1986 and 1987, we take the pre-reform federal tax to be that which existed just prior to February 1986 and the post-reform law to be that after the tax reform is fully implemented. Provincial corporate rates and mining tax provisions of 1987 are used for both pre-reform and post-reform stages.

Tax reform is still subject to change in Canada, even with the proposed reforms made in 1987. While the federal tax measures were introduced as a Ways and Means Motion in December 1987, at the writing of this monograph (mid-1989) the legislation had still to be passed. New or alternative measures

could be adopted in those cases in which there remains significant negative reaction. Indeed, in the case of flow-through shares, this has already occurred, with the introduction of the Canadian Exploration Investment Program (CEIP), designed to reduce the impact of tax reform on flow-through shares. Moreover, provincial governments, especially Alberta, Ontario, and Quebec which collect their own corporate tax, are still responding to the federal tax measures. Provincial statutory tax rates may change and the provinces may not adopt the federal changes made to the corporate tax base. For these reasons, we caution the reader that our evaluation of corporate tax reform in Canada is based on information available to us at the time of writing.

In tables 16, 17, 18 and 19, we compare the effective tax rates faced by mining firms pre- and post-federal corporate tax reform. Table 16 examines the impact of corporate tax measures on mining firms, aggregated across Canada. To determine the exact nature of changes made, we decompose the combined federal and provincial effective tax rate into its components: federal corporate, provincial corporate and provincial mining tax rates. In table 17 we examine the impact of tax reform by province for taxpaying companies only. In tables 18 and 19, we consider the impact of corporate tax reform taking into account the special cases considered previously in this chapter: capital risk; tax loss companies; and different forms of financing.

Impact of Tax Reform: The Case of Taxpaying Firms

In tables 17 and 18, we show the impact of tax reform on mining investments in depreciable capital, exploration and development, depletable assets and inventories for all provinces. We assume for these calculations that the firms are fully taxpaying and face "income" risk only. The effective tax rate measures for each component (federal corporate, provincial corporate and provincial mining tax) are calculated by setting tax parameters equal to zero for the other two taxes.

The estimates provided in table 16 suggest that federal corporate tax reform will have a negative effect on mining investment. The effective tax rates rise (become less negative) for all four investments, especially for inventory capital which becomes much more highly taxed than before. This is a result of the elimination of the inventory allowance. While tax reform has a negative impact on the mining sector, there remains a significant subsidy for exploration and development, investments in depreciable capital and the holding of depletable assets. A negative effective tax rate for depletable assets implies that the tax system, after reform, continues to discourage depletion. The decomposition of effective tax rates in table 16 provides useful information with respect to the distortions created by corporate and mining tax regimes. Prior to tax reform, the federal corporate income tax is most responsible for subsidizing mining investments; that is, effective corporate tax rates were most negative at the federal level. Provincial corporate income and mining taxes are less

Table 16:
Impact of Federal Corporate Tax Reform on Mining Industry for Taxpaying Firms
Effective tax rates (percent)

	Pre-Tax Reform				Post-Tax Reform			
Assets	Federal	Provincial	Mining	Total	Federal	Provincial	Mining	Total
Depreciable	-64.4	-5.2	-13.8	-84.2	-31.9	1.1	-13.8	-62.0
Exploration and development	-24.7	-3.2	-3.9	-44.0	-7.7	-0.9	-3.9	-22.3
Depletable	-31.3	-9.7	-0.7	-49.8	-24.4	-9.7	-6.7	-34.5
Inventory	15.5	6.9	24.2	49.3	34.3	1[illegible]	24.2	114.1

Table 17:
Impact of Tax Reform by Province — Taxpaying Only
Effective tax rates (percent)

Assets	Ontario	Quebec	British Columbia	Newfoundland	New Brunswick	Manitoba	Nova Scotia	Saskatchewan Uranium	Saskatchewan Potash	Total
Depreciable										
Pre	-63.3	-78.3	-84.2	-78.9	-82.0	-97.1	-85.7	-2831.7	69.9	-126.4
Post	-23.2	-36.2	-26.2	-23.8	-25.7	-39.3	-31.3	-1967.2	126.1	-61.7
Exploration and Development										
Pre	-31.2	-35.5	-44.0	-45.1	-45.4	-45.2	-44.4	-1617.0	-2.4	-56.2
Post	-33.3	-29.1	-42.8	-38.3	-37.4	-38.3	-37.4	-33.6	-28.4	-34.5
Depletable										
Pre	-40.3	-36.1	-49.8	-45.2	-44.4	-45.2	-44.4	-39.2	-34.4	-41.4
Post	-33.3	-29.1	-42.8	-38.3	-37.4	-38.3	-37.4	-33.6	-28.4	-34.5
Inventory										
Pre	61.2	41.9	49.3	47.7	53.6	54.0	47.9	720.5	435.5	84.3
Post	97.1	66.4	84.0	85.0	90.4	91.8	84.1	644.6	435.7	114.1

Table 18:
Impact of Tax Reform on Mining Capital — Special Cases
Effective tax rates (percent)

	Capital Risk		Non-Taxpaying			
			Current		Start-up	
Assets	Pre	Post	Pre	Post	Pre	Post
Depreciable	-157.1	-71.1	-58.7	-48.5	39.4	65.3
Exploration and development	-56.2	-22.3	-11.2	-6.7	-48.5	-16.5
Depletable	-41.4	-34.5	-10.5	-8.8	124.4	92.5
Inventory	84.3	114.1	32.6	39.0	250.0	241.1

distortionary except in the case of inventories and processing which face a high positive and negative mining effective tax rate (calculations for processing are not shown[13]).[14]

The elimination of earned depletion and the reduction in CCA for new mine assets and other extraction assets under tax reform lead to a sharp increase in federal tax rates. Moreover, the reduction in corporate tax rates has the surprising effect of increasing effective tax rates when the tax rate is negative. The reason for this is that the value of fast CCA and interest cost write-offs is reduced when the statutory tax rate is lowered. Thus, depreciable, exploration and development, and depletable assets are less favoured under a tax reform that lowers the statutory corporate tax rate. There is, however, further room for reform if the desire is to make the federal corporate tax more neutral with respect to investment. Depreciable capital, exploration and development, and depletable assets remain subsidized under federal law.[15] In fact, the treatment of inventory capital, which was already highly taxed, has worsened after tax reform, due to the elimination of the inventory allowance.

Tax reform also increased provincial effective corporate tax rates (except for depletable assets). Unlike federal reform which includes a reduction in the

13 See Boadway, Bruce, McKenzie and Mintz (1987).

14 Note that it is not valid in table 16 to sum the separate federal, provincial and mining effective rates to obtain the total, or overall, effective tax rate. This is because of various non-linearities and interactions among the three systems in the effective tax rate formula.

15 In the case of exploration of development, there remains a subsidy due to the nondeductibility of exploration and development expenditures from the resource allowance base (which is 25 percent of mining profits gross of interest and CEE and CDE). This allows exploration and development to be expensed at the full statutory tax rate even though the income generated by the expenditures is taxed at the statutory tax rate net of the resource allowance.

federal corporate tax rate, provincial tax reform is assumed to keep the statutory tax rate the same. The base-broadening measures, such as reduced CCA and the elimination of earned depletion and the inventory allowance have raised provincial corporate tax rates. For depreciable assets and exploration and development expenditures, the provincial corporate tax is almost neutral (although these aggregate calculations mask considerable variation in effective tax rates across individual assets classes).

The impact of tax reform on mining investments across provinces is the same as that shown for the aggregate (see table 17). Effective tax rates on mining firms in each province increase as a result of federal tax reform for the reasons discussed above. Inventories become more highly taxed while effective subsidy rates for other types of capital fall. Despite these changes, there still remains significant tax distortion.

Impact of Tax Reform: Special Cases

The above assessment of tax reform considers only firms that face income risk, are always taxpaying, and use conventional sources of debt and equity finance. In tables 18 and 19 we consider the alternative cases of capital risk, tax losses and flow-through-share financing of exploration and development. In table 18 we show the impact of tax reform on mining investments that face capital risk resulting from uncertain economic depreciation. Tax reform has a rather important effect in raising effective tax rates for this case, similar but in larger scale to the impact described for income risk. Capital risk is especially important with regard to the use of depreciable capital. With capital risk, the effective tax rate is increased substantially from -157 percent to -71 percent. For income risk (table 16), the increase is only from -84 percent to -62 percent. The base-broadening measures raise the cost of capital risk faced by the mining firm, since capital write-offs allow the government to share the cost capital risk with the private sector. Tax reform also removes much of the advantage given to mining investments that face capital risk that are now taxed at almost the same rate as investments that face income risk.

Table 18 also shows the impact of tax reform on tax loss companies for the two cases we defined earlier: currently non-taxpaying and start-up investments. In general, tax reform raises the effective tax rate on tax loss companies that are currently non-taxpaying. The impact is not too large since the firms do not expect to pay taxes for some time (in present-value terms, reduced tax write-offs do not affect tax payments that are owing many years from now). For start-up investments, tax reform increases the effective tax rate on depreciable and exploration and development capital and reduces the tax rate on depletable and inventory assets. In these calculations, however, we do not take into account the impact of tax reform on the time taken to use losses. If start-up firms are able to use losses more quickly, effective tax rates may be lower in value than those calculated in table 18.

In table 19, we show the impact of tax reform on investments in exploration and development that may be financed by conventional equity sources or flow-through-share financing. These calculations use Canadian personal tax rates, assuming that Canadian savings are marginal sources of finance for investments in exploration and development. We assume the shares are issued by an Ontario corporation to the highest-bracket Ontario shareholder. The calculations take into account the following tax reform changes:

- the reduction in corporate tax rates;
- the elimination of earned depletion;
- the reduction in statutory personal tax rates on interest income, dividends and capital gains for the top-bracket investor;
- a higher inclusion rate for capital gains and a lower dividend tax credit rate;
- the investment loss provision that requires the capital gains exemption to be reduced by the value flow-through-share tax writeoffs;
- the introduction of the Canadian Exploration Incentive Program (CEIP) for exploration expenditures financed by flow-through shares.[16]

Effective tax rates are presented for both fully taxpaying and currently non-taxpaying corporation for three types of regimes under alternative assumptions regarding the capital gains tax rate (on an accruals basis). The first is the pre-reform system which existed prior to 1986. The second is the system originally proposed in the White Paper in June 1987. In the original proposals, earned depletion was eliminated outright with no program to replace it, and resource deductions reduced the amount eligible for the capital gains exemption dollar for dollar. The third system considered is the post-reform regime that was eventually implemented. In the post-reform regime, a CEIP grant of 30 percent is provided for exploration financed by flow-through shares (up to $10 million); moreover, only 50 percent of resource deductions are included in cumulative net investment losses for purposes of determining the amount eligible for the capital gains tax exemption. In table 19, we present effective tax rates for all three systems under the alternative assumptions that capital gains are fully taxed (at the effective *accrual* rate[17]), and where they are not taxed at all. The former corresponds to the situation where the marginal investor has used up all of his capital gains exemption, and the latter to the case where he has not.

Table 19 highlights the benefits of flow-through shares as a method to finance exploration. Under the pre-reform system, even a fully taxable corporation would prefer to use flow-through shares rather than new equity issues given the tax parameters we have assumed (see appendix B). For a currently non-taxpaying corporation, flow-through shares were by far the preferred source of finance prior to the tax reform, with a large negative effective tax rate of -45.2 percent.

16 For a more in-depth discussion of all of these changes see chapter 2.

17 See appendix B for a discussion of how the effective accruals capital gains tax rate is calculated.

Table 19:
Tax Reform and Flow Through Shares: Combined Personal and Corporate Effective Tax Rates on Exploration[a] (percent)

	Pre-Reform		*Original Proposal*		*Post-Reform*[b]	
	C = 12%	C = 0%	C = 15%	C = 0%	C = 15%	C = 0%
Taxpaying						
Retentions	-33.2	-33.2	-10.1	-10.1	-10.1	-10.1
New equity	20.1	48.9	18.4	48.9	18.4	48.9
Flow-through shares	-21.0	-21.0	15.9	15.9	5.0	9.3
Non-Taxpaying						
Retentions	-5.5	-5.5	-1.8	-1.8	-1.8	-1.8
New equity	31.5	51.5	19.5	42.3	19.5	42.3
Flow-through shares	-45.2	-45.2	-13.2	-13.2	-21.4	-18.2

C = effective accrual capital gains tax rate

[a]Assumes the shares are issued by a Ontario company to a high-bracket Ontario shareholder (ignores provincial mining taxes).

[b]Assumes the expenditures are eligible for CEIP grants.

The original tax reform proposals significantly reduced the attractiveness of flow-through-share financing. For non-taxpaying corporations the effective tax rate on exploration financed in this manner rose significantly to -13.2 percent, but was still negative. The original reform proposals thus did much to reduce the incentives for exploration relative to the very generous pre-reform regime; nevertheless, a significant subsidy was still granted to exploration financed in this manner. However, since tax loss companies tend to be junior companies that often invite larger taxpaying companies into limited partnerships so that the shares can sell more easily in the market, under the original proposals flow-through-share financing was likely to be discouraged in general. This could lead to non-taxpaying firms facing a disadvantage compared to taxpaying firms in financing exploration and development since these taxpaying firms can use more effectively their corporate tax write-offs for exploration and development.

The CEIP grants were introduced to address this perceived problem with the proposed regime. From table 19 it is evident that, while they are not as generous as the pre-reform regime, the grants do indeed lower the effective tax rate for exploration (in the case of non-taxpaying corporations it becomes more negative). This places non-taxpaying corporations on a more even footing with fully taxpaying companies. Nevertheless, it is clear from the table that flow-through shares are a poor substitute for full refundability.

This evaluation of tax reform is contingent on current market variables such as inflation rates, financing costs, risk and economic depreciation rates. It is quite likely that these economic variables will change in value in the future, especially with regard to inflation and risk. This implies that the impact of tax reform could be different from that which we discuss here. For example, if inflation increases, the variation in effective tax rates will rise. Investment in inventories and depreciable assets that are written off for tax purposes using the original rather than replacement cost of assets could be more highly taxed. On the other hand, tax provisions are more generous when interest, uanadjusted for inflation, is deducted from the tax base; effective tax rates on short-lived capital and exploration and development (that is expensed) fall with higher inflation rates.

CONCLUSIONS

The empirical application of our effective tax rate methodology suggests that corporate income and mining taxes are generally favourable to the mining industry. In fact, investment is subsidized at the margin rather than taxed for most types of capital expenditures. Although mining firms are paying taxes on their inframarginal and marginal profits, the negative effective tax rates suggest that current corporate and mining taxes are poor collectors of resource rents.

We also find that corporate and mining taxes are highly distortionary. Some investments are discouraged (such as inventories), others encouraged by the tax system (such as exploration and development, depreciable assets and depletable assets). In some provinces, tax systems have also encouraged firms to process concentrates in the province in which they are produced through further processing allowances..

The tax system distorts some activities relative to other ones in certain special cases. Investments faced by capital risk are subsidized more by the tax system than are investments that face income risk. Investments and expenditures by tax loss companies have been less favourably treated, compared to investments undertaken by taxpaying firms. Moreover, assets that are financed by equity are less favourably treated, when compared to assets financed by debt.

Federal tax reform has generally reduced the level of subsidy given to expenditures and investments in the mining industry. Effective tax rates become less negative in most cases, although the level of subsidy remains large. Thus, the tax system in Canada still remains a poor collector of resource rents after tax reform.

In the next chapter, we discuss reform issues related to the taxation of the nonrenewable resource sector. Although federal corporate tax reform has made a number of changes which move the system in the right direction, we believe more substantial reform of corporate and mining tax systems is called for, in light of the effective tax rate analysis presented in this chapter. Our suggestions for tax reform would remove many of the distortions caused by taxation, thus eliminating the variation and size of effective tax rates faced by the Canadian mining industry and, at the same time, improving the tax system as a rent-collection device.

4. Tax Policy Implications for the Mining Industry

THE OBJECTIVE OF TAXING MINING FIRMS

Most of the discussion in the previous chapters took a positive economics perspective, analyzing the current institutional setting and evaluating the distortions it implies. In this chapter, we discuss the taxation of the mining industry from a normative, or policy, perspective. It is useful to begin by putting mining taxation into the broader context of business tax policy more generally. Although there may be reasons for imposing specific taxes on mining firms (or on other resource firms), these taxes will co-exist with other taxes that are levied on business firms. It is difficult to evaluate mining taxation fully without taking account of the interaction of various sorts of taxes with a view to assessing their overall impact. The marginal effective tax rates discussed in chapter 3 show clearly how the corporate income tax and the provincial mining taxes interact to influence firms' decisions.

In addition to evaluating mining tax policy in the broader context of business taxation in general, account should also be taken of some other aspects of the economic and institutional setting in which Canadian taxes exist. On the institutional side, a key feature of the Canadian economy is its federal nature. In the case of resources, the assignment of responsibility to the provinces for resource development is explicitly stated in the Constitution. In addition, the provinces are given the right to levy virtually any type of taxes on resources. These provisions are widely interpreted as meaning that the provinces have property rights over resources within their provincial boundaries. On the other hand, it is not obvious that the provinces have exclusive rights to resources, including the right to obtain all the revenues from them. The federal government also has unrestricted rights of taxation, and one could take this as implying that they have some right to a share of resources revenues. Indeed, Section 36 of the Constitution Act of 1982 assigns the responsibility to the federal government for making equalization payments across provinces to enable all provinces to have the ability to provide comparable levels of public services at comparable tax rates. To the extent that provincial inequalities are due to differences in resource endowments, it would be difficult to imagine an equalization system which did not at least implicitly redistribute revenues out of a resource-rich region.[1]

1 For a discussion of the redistribution of resource revenues among provinces and the federal government in the context of the Canadian equalization system, see Boadway, Flatters and LeBlanc (1983).

As far as economic considerations are concerned, the one that has the most important implications for business tax policy is the degree of openness of the Canadian economy to both trade and capital flows. In the extreme case in which capital is perfectly mobile between Canada and the rest of the world, financial rates of return in Canada would essentially be determined in international capital markets, and this will be so for both the rate of return savers are able to obtain in Canada and the rate of return that will be required on investment in Canada. Indeed, the marginal effective tax rate calculations in the previous chapter implicitly take this openness into account, measuring the distortion implied by the tax regime with respect to the internationally determined required rate of return on investment. On the other hand, capital may not be perfectly mobile, in the sense that rates of return in Canada may diverge from those elsewhere because of factors specific to the Canadian economy. In this case, we could not treat rates of return on capital as completely exogenous to Canada, although presumably international capital markets would still have some degree of influence on domestic rates of return. Our proposals for tax reform must be consistent with these possible effects of international capital flows on Canadian capital markets.

We begin this section with a general discussion of the purposes of taxing business income in general and the income of mining firms in particular. Some of our arguments will apply more generally to all businesses and some will be particularly relevant to mining. Perhaps the most general way to pose the question of the role of business taxes is as follows. A good part of business income is generated through corporations. Ultimately the business income of corporations accrues to the owners of the corporations. In view of that, a natural question to ask is: Why tax income at the corporate level at all? Why not just tax the income as it accrues to its owners? The two major purposes of corporate taxation listed below address precisely this issue. These are then followed by some subsidiary roles of corporate or business taxation. In subsequent sections, we consider the implications of these objectives for the design of taxes in the mining industry.

The Withholding Argument

The classic argument for taxing corporations, and the one which was emphasized by the final report of the Royal Commission on Taxation (1966)(the "Carter Report"), is the withholding one. It applies to all corporations, not just those in any particular industry. The argument is based on the idea that the corporate income tax is a tax on capital income at source. This capital income ultimately accrues to the owners of the assets in the corporation, be they equity owners or debt holders. Under an ideal comprehensive income tax, this income should be taxed as income of shareholders at the personal level. The reason why it is necessary to use a corporate tax to withhold at source is that some forms of capital income will not be taxed at the personal level as it accrues to the

owners of the corporation. Some of it might be taxed only at a later date, and some might escape domestic personal taxation altogether due to the existence of foreign shareholders and creditors. There are two general circumstances in which corporate source income will not be taxed at the personal level as it accrues: in the case of accrued capital gains, and of foreign-owned corporations.

Accrued capital gains

Domestic shareholders in a corporation may obtain their equity income in one of two forms. If the profits of the corporation are distributed to shareholders, the income will come in the form of dividends. On the other hand, if they are retained and reinvested, shareholders will receive accrued capital gains. Personal tax systems which tax capital income typically tax dividends as they are received, but only tax capital gains on realization. This would provide shareholders with an incentive to postpone payment of personal taxes by retaining and reinvesting equity income in the corporation rather than paying it out as dividends: the so-called "lock-in effect". The corporate tax may be viewed in part as a method for avoiding this by taxing the income as it accrues at source, whether or not it is distributed. According to this view, the corporate tax should be viewed as a device for withholding taxes against domestic shareholders who will eventually be taxable at the personal level. When the income finally does enter the personal tax base, recognition should be given to the fact that some taxes have already been withheld at source. In other words, the personal and corporate taxes should be integrated, in the sense that credit should be given at the personal level for corporate taxes that have been withheld at source. The methods for doing this will be discussed below.

The above constitutes the traditional argument for using the corporate tax as a withholding device, as found for example, in the Carter Report. As we shall see when we discuss design issues below, there are a couple of important caveats that must be kept in mind when using this withholding argument for tax policy purposes. The first is that this argument for withholding applies only to the extent that the personal tax system is intended to tax capital income on an accruals basis. Many economists have become convinced that a fairer and more effective tax system is one which taxes persons on the basis of their personal consumption expenditures.[2] If such a tax system were to be implemented, there would be no need to use

2 See, for example, Economic Council of Canada (1985) and Royal Commission on the Economic Union and Development Prospects for Canada (1985).

the corporate income tax to withhold against the earnings of domestic shareholders at source.[3] The existing personal tax system falls somewhere between a tax on income and a tax on consumption expenditures since a substantial proportion of capital income is, in fact, sheltered by one means or another. The prime example of this is saving for retirement through registered pension funds or registered retirement savings plans, both of which accumulate tax-free.

The other caveat, and it may be an important one, is that the argument for integrating the corporate and personal taxes must be tempered by the way in which Canadian capital markets are affected by their interrelationship with international capital markets. As we shall discuss in more detail below, full openness of the Canadian economy to world capital markets would imply that rates of return in Canada are largely determined on world capital markets rather than by the interaction of supply and demand conditions at home. In this extreme case, this will further imply that taxes levied on corporate income at source will not affect the return that shareholders obtain. Therefore, the case for integrating the corporate and personal taxes as a way of eliminating the effect of the former would disappear. Indeed, integration would serve only to subsidize saving.

Foreign-owned corporations

The other reason for withholding arises when shareholders are non-Canadian. Since they are not taxed at the personal level at all in Canada, corporate-source income accruing to them would escape taxation altogether if it were not withheld. A major consideration when designing the corporate tax to withhold against foreigners concerns the international tax-crediting arrangements. Typically, foreign corporations operating in Canada pay taxes in their home jurisdiction and receive some credit for taxes paid in Canada. Provided Canadian tax liabilities do not exceed those that can be credited, there is a pure transfer of corporate tax revenues from the foreign government to the Canadian government. In designing the corporate tax, it is obviously worth exploiting this tax transfer. (It should also be noted that mining taxes are not credited abroad, so this argument does not apply to them.) At the same time, if the amount of Canadian taxes exceeds those credited abroad, the excess tax liabilities will ultimately be borne by Canadians, and investment in Canada will be reduced since the foreign corporations must earn a rate of return after tax in Canada which is determined on international capital markets. Thus, the ability to have taxes

3 An exception to this occurs if the tax treatment of equity shares held by households is such that their capital income is exempt from taxation (so-called "tax-prepaid" treatment). In this case, any rents or windfalls which are used for consumption would effectively go untaxed. An argument for using a cash flow corporate tax as a withholding device in these circumstances could be made. This is discussed in detail in Boadway, Bruce and Mintz (1987).

credited abroad sets a sort of limit to the level of taxes that should be set domestically. In fact, it is the lack of liberal foreign tax arrangements that prevents the withholding function against foreigners to be accomplished entirely through direct withholding taxes. This is because Canadian corporate taxes are typically creditable (for example in the United States) while direct withholding taxes on patriated income are not. The same arguments that apply for integration in the above case also apply here, as do the same caveats in an open economy.

In practice, it is not possible to design the corporate tax to apply differently to foreign and domestic shareholders, and it would be contrary to international tax treaties to try to do so. Therefore, a tax designed to withhold against foreigners must necessarily apply to domestic shareholders, and vice versa. This means that both the design of the corporate tax for withholding and the integration features must accomplish both objectives within the same general system.

The Rent Collecting Argument

The withholding argument for taxing firms applies to all corporations. This second argument applies more selectively, and includes the resource industries. The rent collecting argument recognizes that there are certain types of activity in the economy which generate economic rents. As discussed in chapters 2 and 3, economic rents refer to any revenues earned by a firm over and above the full economic (opportunity) cost of producing those revenues. The sources of rents include natural resources, monopoly, locational advantages, the return to fixed factors over and above their best alternative use, and generally any other special advantage enjoyed by a firm.

The case for taxing economic rents is an old one and has played a prominent role in the economic analysis of corporate taxation. Both efficiency and equity considerations are important in this regard. A tax on rents is a perfectly neutral or efficient tax, in the sense that it does not distort decision-making on markets. The empirical estimates in chapter 3 measure the extent to which the current system deviates from a pure rent tax. The estimates indicate that in some cases the deviation is quite significant.

The equity arguments may not be considered as unambiguous since they rely on some value judgments. The equity argument for taxing rents relies on the view that the rents are in some sense part of the property rights of the public sector. In the case of resources, this is like saying that the ownership of the natural resources lies with the public, at least partly. This view seems to accord with the views of provincial governments in Canada (and of the Constitution), as all provinces currently exercise some right of ownership over resources by virtue of special taxes they impose on resource industries (such as provincial mining taxes). At the same time, there are those who would argue that to impose a tax on, say, resource rents would be horizontally inequitable since it would

tax differentially two different types of returns from the same resources. Furthermore, to the extent that resource rents were anticipated, they would already be capitalized into asset prices. To introduce a tax on rents would impose a windfall loss on current asset owners. Thus, the equity case for taxing resource rents is ambiguous. Nonetheless, provincial governments do tax resources, presumably with the objective of obtaining their share of rents. It would seem to be sensible to study whether or not these taxes were being imposed in an effective way, and indeed much of the analysis of the preceding chapters was devoted to doing just this. Our discussion below is intended to show that there are feasible ways of taxing economic rents accruing to resources, and that the resource firms themselves ought to find that a proper rent tax is preferable to the existing system of provincial resource taxation.

Risk-Sharing and Financing Roles

Depending on its design, the corporate tax system may also fulfill two subsidiary roles. It may facilitate the taking of risk by firms in the private sector, and it may assist in the financing of small and growing businesses. Consider, for example, a corporate tax system which is based on equity income. This approximates actual corporate tax systems, and corresponds with a tax system that one might prefer on withholding grounds. In an uncertain world, the equity income of the firm will be random and the shareholders will bear the risk associated with this randomness. To some extent, they will be able to diversify their risk by holding a portfolio of assets. The firm itself may also diversify for its shareholders by undertaking a variety of activities (although this makes sense only if firms are somehow able to diversify more cheaply than individuals, as a result, for example, of transaction costs). Imagine now that the government imposes a business tax on the equity income of the firm. If the tax is at a uniform rate and treats losses symmetrically with gains (i.e., has full loss offsetting), as documented in chapter 3 the government will share in all the income of the firms proportionately, be it positive or negative. This implies that the tax will reduce both the expected return and the variance of the equity income of the shareholders. It is as if the government is a passive (non-voting) shareholder. If uncertainty takes the form of income risk, we saw in chapter 3 that such a full loss offset system allows for the effective deduction of risk, and does not discriminate against risky investments *vis-à-vis* riskless ones. In the case of capital risk (uncertainty regarding future capital prices and/or physical depreciation) the impact of taxation on risky investments depends upon the generosity of capital write-offs. Indeed, we saw in chapter 3 that generous write-offs in the mining sector may well encourage investment in projects with capital risk.

At first sight, this inducement might be considered to be a good thing from society's point of view. However, there are a number of additional considera-

tions that must be taken into account before that judgment is rendered. First, the tax system may not, in fact, offer full loss offsetting. Indeed, as we saw in previous chapters, the Canadian one does not. In this case, losses will not be treated symmetrically for some firms. For firms unable to offset losses fully, the government will share in the good returns, but will not share equally in the losses. In this case, the inducement to undertake risk may not be present; the estimates in chapter 3 confirm this, as we saw effective tax rates increase for firms which are not fully taxpaying. Second, when the government is sharing in the equity returns of the firms and assuming part of the risk of the firms, it is obtaining random tax revenues. The risk involved in these random tax revenues must ultimately be borne by the taxpayers. In principle, it could offset the reduction in risk due to the sharing in the equity income in the first place. Whether or not society is better off or not with government sharing in the risk of the private sector depends upon whether or not the government is better at pooling risks than the private sector. In a world where capital markets function well, one would not expect the government to have any particular advantage in assuming risk over and above the private sector. In such a world, individuals ultimately bear all the risk, be it through fluctuations in equity income or fluctuations in the provision of government goods, services and transfers. Perhaps the most that can be said about the effect of taxation and risk-taking is that, if the government taxes the incomes of risky enterprises, at the very least it ought to ensure that the tax system has full loss offsetting. In the case of uncertain income, this will eliminate distortions for the risky firms. In the case of capital risk, only a move to *ex post*, or full replacement cost, tax depreciation will fully remove the distortion, as discussed in chapter 3.

Related to this is the effect of taxation on the ability of firms to obtain financing. Business taxes which are levied either for withholding or for rent-collecting purposes will usually follow a fairly predictable pattern over time for any particular type of firm. Firms which are small and growing will typically have negative tax liabilities because of their large cost component relative to revenues generated. The opposite is true for older and more established firms. It is precisely when these negative tax liabilities are accruing that the firm's cash flows will also be negative and the firm will be requiring external financing. If firms have some difficulty in raising funds, as may be the case for small firms, refunding negative tax liabilities will have a beneficial effect on the firm since this will represent one form of financing. The effect will be strongest with a tax system which actually uses cash flows as the tax base, provided negative tax liabilities are fully refundable. As we shall see below, a cash flow base is ideal for the purposes of rent-collecting, and may be particularly relevant as a form of resource taxation. Incorporating refundability into it assists both the financing and the risk-taking properties of the tax.

The Corporate Tax as an Instrument for Industrial Policy

One final, and subsidiary, use for the corporate tax is as a device for accomplishing industrial policy goals. Many incentives aimed at assisting particular industries or types of activities are delivered through the corporate and resource tax systems. These include incentives for research and development, for exploration, for investment in manufacturing and processing, and for investment in depressed areas of the country. We shall have little to say about the use of the corporate tax for these purposes. On purely economic grounds, most such tax incentives have little to recommend them. A possible exception is the preferential treatment of research and development, since economic principles suggest that there may be underexpenditure on these activities because of the externalities that they create. Otherwise, interference with the market mechanism has little to offer from a purely economic point of view. The most we can do is document the effects of these tax expenditures on the incentive to undertake various types of expenditures, as we have done in the calculations in the previous chapter.

DESIGNING A BUSINESS TAX SYSTEM TO ACCOMPLISH THESE OBJECTIVES

Taxes on business firms have to accomplish more than one objective, the two most important of which are the withholding and the rent-collecting functions discussed above. Not surprisingly, these objectives call for different tax designs. The ideal bases will be quite different, and the withholding tax may be much more broadly based than others. While it is technically possible to design a single tax system which will accomplish both objectives simultaneously, such a tax system would be quite complex.[4] Furthermore, the stakes of the two levels of governments in the two types of taxes may be quite different. It could be argued, for example, that the provinces should command a much larger share of a rent tax as compared with a withholding tax because of the property rights granted them by the Constitution. Therefore, for practical purposes, a tax designed to fulfill the withholding function might be separate from one designed to collect rents.

Given the institutional setting in which tax policy is formulated in Canada, there is a natural assignment of tax types to these two functions. The existing corporate tax might be viewed as essentially a withholding tax and should be designed with such an objective in mind. (This was also the view of the Carter Report.) It should apply broadly to all corporations, and be levied jointly by the federal and provincial governments. Ideally, the tax should be harmonized

4 The problems of incorporating both the withholding function and the rent-collecting function within the same tax base are discussed in Boadway, Bruce and Mintz (1984).

between the two levels as it largely is now under the Tax Collection Agreements. Any integration with personal tax should be done only for the withholding component of the corporate tax, not for the rent-collecting component.

The rent-collecting tax should be quite separate from the corporate tax, and initially it might be applied only to resources. It seems natural to think of the existing separate provincial taxes on resources (e.g., mining taxes and oil and gas royalties) as being levied primarily for the purpose of capturing part of the resource rents for the provinces. Thus, a rent tax might simply build upon or replace these. There are a number of problems that need to be addressed in doing so. The first problem is that, as is very evident from the calculations presented in chapter 3, the bases of the current provincial resource taxes vary considerably from rents. Provincial mining taxes as they currently exist in Canada function poorly as collectors of rent. We will indicate in the following parts of this chapter the sorts of reforms that would be required to make these taxes equivalent to rent taxes.

Next, the existing taxes provide only for provincial revenues and allow no access by the federal government to the rents of provincial resources. Indeed, if anything, federal tax collections are adversely affected by provincial taxation because of the Resource Allowance deducted from the federal tax base in recognition of provincial tax collections. The lack of direct access by the federal government to resource rents has from time to time induced the federal government to undertake indirect measures to obtain a more general sharing of the rents across the country, such as direct price controls and export taxes, both of which are highly distortionary. A related problem is that there is currently no vehicle for harmonizing resource taxes across provinces, as there is with both the personal and the corporate income taxes (and as there may be in the future under a revised national sales tax system). As the discussion of chapter 2 highlighted, provincial mining tax systems differ considerably among provinces. In an ideal world, these two problems of harmonization of resource taxation and an agreed method of sharing the rents collected between both levels of government might be accomplished by a Tax Collection Agreement applied to resources, whereby one uniform tax base applies nationwide and the tax shares are explicitly defined. Whether this is politically feasible is another matter. The provinces might find it difficult to agree to such a measure for fear that their share of the resource tax room might be eroded over time. For such a measure to be practical, a more explicit sharing rule would have to be devised than now exists with the corporate and personal tax agreements between the federal and provincial governments.

In the remainder of this section, we discuss the design of a corporate tax base for withholding and the design of a resource tax base for collecting rents as well as the relations between the two. In the subsequent sections, these ideal bases will be used as a benchmark against which to propose reforms to the existing system.

The Withholding Corporate Tax Base

The corporate tax is essentially a device for withholding at source taxes which will ultimately accrue to shareholders, some of which will be taxed in their hands. As mentioned, there are two potential reasons for withholding at source. One is to withhold against income accruing to foreign shareholders which would otherwise escape taxation in Canada entirely. The other is to withhold against earnings which accrue to domestic shareholders but which are retained and reinvested in the corporation and therefore are not immediately taxable at the personal level. This latter view of the corporate tax loses much of its force when two considerations are taken into account. The first is that this rationale is justified only if one of the objectives of the personal tax system is to tax all accrued capital income at the personal level. This is far from the case in Canada. Capital income in Canada is substantially sheltered from personal tax by intentional tax measures. For example, pension funds (RRSPs, RPPs, DPSPs) are sheltered from taxation entirely, so no withholding need be done on their behalf. Also, the government has recently enacted measures, in the form of a lifetime exemption, to ensure that a considerable portion of capital gains, at least to non-wealthy persons, are tax exempt. Many other types of asset income are also tax exempt or preferentially treated, such as the rate of return on housing, the rate of return on insurance (at least until the recent reform), and the rate of return on human capital investment. Indeed, it has been argued that the existing income tax system is really closer to a consumption tax system since a high proportion of assets are held in tax-sheltered form.[5] To the extent that this is so, the case for withholding against domestic residents using the corporate tax is weakened.

This case for withholding also loses some of its force when one recognizes the full consequences of Canada's capital markets being highly open to international capital markets. This implies that rates of return on savings and investment are largely determined on international capital markets. Because of the ready access to international capital markets by both savers and investors, the rate of return on domestic savings must conform to what can be obtained on international capital markets by acquiring foreign assets. Similarly, the rate of return that investment must pay after tax might be expected to conform to some extent with what creditors can obtain on foreign capital markets. This implies that the domestic savings and investment sides of Canadian capital markets are partly segmented and that any tax measure applying to firms will have limited effect on the rate of return to domestic savers. Thus, withholding taxes from corporations operating in Canada will have little effect on the rate of return domestic shareholders can obtain, and therefore will be ineffective as a withholding device. A similar implication applies on the savings side. Tax measures applied through the personal tax system on domestic saving will affect

5 See, for example, Boadway, Bruce and Mintz (1987).

mainly the after-tax return to savings. The pre-tax return to savings and the rate of return on investment will be largely unaffected since both must conform with internationally determined rates of return. We will use this later to suggest that integration of the personal and corporate tax systems will be to a large extent ineffectual in undoing the effect of taxes withheld at the corporate level.

These arguments suggest that the design of the corporate tax should be guided by the desire to withhold against foreign shareholders. In designing a corporate tax for this purpose, two prime considerations must be borne in mind, both of which are consequences of the open-economy assumption. The first concerns the extent of foreign tax crediting of Canadian taxes paid by foreign corporations operating in Canada. Foreign corporations operating in Canada will typically incur tax liabilities in their home country from their operations in Canada. Canadian corporate tax liabilities will to some extent be creditable against these liabilities. To the extent that they are, the Canadian tax combined with the foreign tax credit will effectively transfer revenues from the foreign treasury to the Canadian one with no effect on the investment decision of the firm. Naturally, the Canadian government would like to exploit this tax transfer to the maximum extent possible. On the other hand, if Canadian tax liabilities are in excess of the amount that can be credited abroad, the foreign corporation will effectively be facing double taxation of its income. The effect of the Canadian tax will be to reduce foreign investment in Canada until the after-tax return it can obtain in Canada rises to what can be obtained abroad. The excess tax will end up being borne not by the foreign shareholders, but by Canadians. Thus, the Canadian corporate tax should not exceed what can be credited abroad.

The other consideration which should be borne in mind when designing the corporate tax is that the tax cannot discriminate between domestic and foreign firms. Thus, any tax that is applied for withholding against foreign firms must also apply to domestic firms. (This is so both for practical reasons and because international tax treaties under which foreign tax crediting arrangements fall do not permit such discrimination.) This implies that, in the process of transferring revenues from foreign treasuries, the corporate tax will also distort investment decisions at home. This fact influences both the choice of tax rates and the choice of a base itself, choices to which we now turn. The point is that the use of the tax for withholding against foreigners must be tempered by the distortions imposed on domestic firms in the process.

The effect of this trade-off becomes clear when we consider the design of the ideal base for withholding against foreigners. If the only concern were to transfer as much revenues from foreign treasuries to Canada, the tax base should conform as closely as possible to the base used by foreign governments for crediting purposes. There are two difficulties with this presciption. The first is that the bases used by foreign governments vary considerably across countries, so it is impossible for that tax base to conform for all. To give one simple

example, the U.S. foreign tax credit applies only when U.S. firms repatriate dividends to the United States. If all countries had the same system, the ideal base might be dividends paid out by the corporation. Unfortunately, other countries have different bases. The second is that, to the extent that foreign tax bases do conform with one another, the tax bases tend to be highly distortionary both in the aggregate and across different types of activities.[6] For example, the tax bases tend to be unindexed for inflation. Capital costs such as depreciation and inventory use are often deducted on an historic-cost basis, and interest costs are deducted on a nominal basis. Furthermore, most offer a variety of incentives to particular types of activities, such as accelerated depreciation on certain types of capital investment and the rapid write-off of exploration and development expenditures in the resource sector. To replicate these tax systems in Canada would also replicate the distortions. Perhaps the simplest way to characterize foreign tax bases is as imperfect measures of equity income generated by the corporation.

Some concept of equity income seems appropriate for the corporate tax base. Virtually all governments give a deduction for interest income, so one would not like to tax the entire capital income accruing to the corporations. Whatever concept of equity income we use as our tax base, it cannot conform exactly with what is being used abroad. Furthermore, to the extent that it did, it would be highly distortionary across industries and types of investment decisions. This suggests that an appropriate tax base for corporate income taxation in Canada might be equity income appropriately defined. This seems an appropriate compromise between the ability to withhold against foreigners and the distortions applied abroad. The tax rate itself should be no more that the average tax rate creditable abroad, and it should presumably also not differentiate across industries. The system should also treat positive and negative tax liabilities symmetrically either through refundability provisions applying to tax credits or through an unlimited carryforward of tax credits with interest. This will help ensure that the tax system does not discriminate against risk-taking.

A tax base which is defined to be true equity income would include the following components. On the revenue side, all accrued revenues of the firm would be included. From this would be deducted all current and most capital costs on an accrued basis. In the case of current costs, labour and all intermediate inputs would be deducted as they accrue: that is, as they are used to produce accrued revenues. Capital cost deductions are somewhat more complicated to define. Basically, all accrued capital costs except for the cost of equity financing would be deductible. These would include true economic depreciation of produced (and in-use) capital goods based on replacement cost, the full replacement cost of inventory usage, the true depletion of resources at replacement cost and the real interest costs incurred on debt. In principle, expenditures

6 This is documented for a selection of countries in King and Fullerton (1984).

on exploration and development, the acquisition of goodwill, and the training of labour ought also to be treated as capital costs and amortized accordingly, but that is very difficult to do. Indeed, it would be impossible to implement perfectly most components of the ideal equity tax base. Inevitably, therefore, we are going to end up with a tax base that is imperfect when judged by the ideal, but that cannot be avoided. In the next section, we shall consider some of the more blatant ways in which the existing system deviates from this ideal.

It should be noted that this tax base on equity income, even if it could be approximated, will still distort the investment decision of firms. As mentioned, that is impossible to avoid. The idea is, however, to define the tax base in a way which discriminates as little as possible across different types of activities but which at the same time acts as a withholding device against foreign shareholders. It should be noted that there is one form of discriminatory treatment which is impossible to avoid, and that is the favouring of debt-financed investment over equity-financed investment. Because interest is deductible in accordance with the way debt finance is treated by foreign tax systems, firms which rely more heavily on debt compared to equity will be at a slight advantage relative to those which rely on equity. Furthermore, the tax system will have an incentive for firms to substitute debt for equity finance. However, the incentive will not be as great as under the present system. Since the present system offers nominal rather than real interest deductibility, the incentive in favour of debt finance is even greater, the more so the higher the rate of inflation.

One final issue is that of the integration of the corporate tax system with the personal tax system. As mentioned, the conventional view as espoused by the Carter Report, has been that if the corporate tax is integrated with the personal tax, the distortionary effects of the corporate tax on domestic investment can be completely undone. Integration would require that full credit be granted to domestic shareholders for the taxes that have been paid on their behalf at the corporate level. In principle, there are two general ways that this could be done. It could be done through the firm itself, by allowing the firm a tax credit on dividends it pays out to domestic shareholders; or, it could be done at the personal level by allowing the shareholders a credit for taxes withheld on their behalf. In practice, the former is not feasible. For one thing, it is very difficult to identify dividends paid to domestic taxpayers. For another, even if a firm could do so, the practice would constitute discrimination against foreign-owned corporations and would be deemed to be in contravention of tax treaties. Thus, the only practical way of integrating is by giving credit to domestic shareholders for taxes paid on their behalf. One way to do so would be to use the dividend tax credit system such as is in place in Canada. Dividends received from Canadian corporations would be grossed up at a rate comparable to the average corporate tax rate paid by the corporation, and the shareholder would be given a tax credit for that amount. For this to apply fairly, it must apply to all dividends received, regardless of whether those dividends are taxable at the personal level.

In particular, the dividend tax credit should apply to pension funds as well as to taxable dividends.

However, we would question the role of an integration scheme for taxes on capital income in an economy with highly open capital markets. As mentioned, tax measures applying to the personal side, of which the dividend tax credit is one, would have little effect on the rate of return that domestic investments must earn. Therefore, they could not succeed in undoing the effects of the corporate tax. Instead, they work largely to increase the rate of return on saving and thus induce more domestic saving; that is, they simply remove the taxation of capital income from the personal tax base. This being so, the role of integration as a means of neutralizing the corporate tax on capital income may be called into question. The usefulness of integration must be evaluated largely in terms of its effect on the rate of domestic saving, and is essentially irrelevant as a determinant of the corporate tax base.

The Rent-Collecting Resource Tax

The withholding corporate tax applies to all corporations. A tax designed to collect rents is a completely separate tax, and is applicable only to activities generating rents. Our discussion here pertains to the nonrenewable resource industries, particularly mining, although the same principles apply to oil and gas. The tax need not be restricted to corporations, but should apply to all firms and individuals engaged in the exploiting nonrenewable resources. In this section, the discussion will centre entirely on the ideal design of such a tax. In the following section, some of the issues that arise in reforming the existing (imperfect) system will be considered.

The principle issue that arises in designing the rent tax is the choice of a base. Unlike the withholding tax, there is no ambiguity in the desired base for a rent tax. Ideally, the base should be economic rents. Defining the components of economic rents is straightforward, but, as we shall see, measuring these components is quite another matter. Many of them are simply unobservable. This section will indicate that there are bases which are administratively feasible and which have the same present value as rents. It should be relatively straightforward to implement such a base.

Economic rents consist of the difference between the accrued value of revenues from sales and the full opportunity cost of generating those revenues. It is essential that all economic costs, imputed or otherwise, be deductible in order to establish a tax base for economic rent. If this can be accomplished, a tax on rents will be completely nondistorting. The tax will not fall on any input used in the production process, so inputs will not be induced to change when the tax is imposed. The base of the tax is, in a sense, the value of the natural endowment of the resource itself after full account has been taken of all costs of discovery and extraction. The following represents the main set of deductions that should be subtracted from accrued revenues at current cost.

Current Input Costs

The accrued costs of all current inputs valued at current prices that are used to generate current revenues should be deductible. These include labour costs, materials, fuels, administrative costs, and the like. Current costs of producing inventory or capital goods should not be deductible; nor should training costs of labour.

Financing Costs

The real costs of financing applied to the replacement value of all types of capital (depreciable capital, depletable assets, inventory, etc.) on hand should be deductible. This includes both the real interest cost of debt financing, as well as the real costs of equity financing, where the latter consists of the minimal rate of return required by equity holders on the funds they have contributed to the firm. The appropriate equity cost would be the risk-free return, if the tax system allowed full loss offsetting. The requirement to use real returns means that rates of return must be indexed for inflation. This indexing is justified for the following reason. Nominal interest rates consist of two components. One is the inflationary component which compensates the creditor for a loss in the value of the debt due to inflation. This inflationary component should be thought of as a partial repayment of principal and not as a component of the rate of return on the debt. Only the second component, the real interest rate, represents the rate of return on debt. The same principle applies to the returns on equity. It might be noted at this point that the requirement to deduct all costs of finance distinguishes a rent tax from an ideal tax on equity income. As we have seen, the only cost of finance the latter allows is the real cost of debt.

Depreciation

The accrued costs of using depreciable capital (machinery and equipment, and buildings) should be deductible. This consists of the true economic depreciation rate reflecting wear and tear, obsolescence, and changes in the real price of the capital all applied to the current replacement value of the capital stock.

Inventory Use

The replacement value of all items taken out of inventory and used to produce current accrued revenues should be deductible.

Resource Depletion

The accrued costs of resource use should be deductible. This essentially means the replacement value of resource stocks depleted and sold for current revenues. In this way, the treatment of resource stocks should be exactly analogous to the treatment of inventory. None of the costs of acquiring the resource should be

deductible when incurred, including the cost of property rights, and exploration and development expenditures. They only become implicitly deductible when the resource is actually sold for revenue.

Other Capital Expenditures

Other capital-type expenditures such as research and development, overhead and marketing should, in principle, be amortized and deducted as they produce revenues.

It should be obvious that the proposed tax base is an unattainable ideal. Almost all the items on the list pose measurement problems, some essentially insurmountable. For example, distinguishing current costs which produce current revenue from those which produce inventory is difficult. Measuring the true rate of economic depreciation is difficult. Amortizing the capital costs of manpower training, research and development, advertising, and the like is very difficult. Costing inventory use and resource depletion at replacement cost as they generate revenues is difficult. The most difficult item to measure properly is the cost of equity capital. The return to equity finance is comprised of two components: the opportunity cost to the shareholders of using their equity in this firm as opposed to elsewhere; and rents. Only the former should be deductible. However, elimination of the rent component from equity income in order to arrive at the cost of equity finance requires that one know what that rent component is, and that is precisely what the cost of equity finance is supposed to be used to discover. Thus, implementation of a tax base consisting of economic rents by allowing the above deductions would be essentially impossible.

Fortunately, this is not the end of the matter. It turns out that there are other tax bases which, though they do not reflect rents directly, are equivalent to rents in present-value terms and can be readily implemented using observable data. Conceptually, the simplest tax of this sort is the so-called *cash flow tax*.[7] In the cash flow tax, the base consists of the real (non-financial) transactions of the firm measured on a cash rather than accrual accounting basis. Actual revenues from the sale of goods and services would be included in the base as they are realized. All current and capital costs would be deducted as they are actually incurred. In the case of mining firms, all current inputs would be expensed whether or not they were used for producing current inputs, for producing inventory, or for producing stocks of resources. No further deductions for inventory would be allowed. Depreciable capital would be expensed when acquired, whether or not it was immediately put to use. No further depreciation or interest expenses would be deducted. All exploration and development costs would be expensed when incurred, and again, no further costs would be

7 The cash flow tax was analyzed by Smith (1963), and its policy implications considered in the so-called Meade Report (Institute for Policy Studies [1978]).

deductible when depletion takes place. The same applies for all other capital-type expenses such as research and development, marketing and manpower training. No deductions would be allowed for purely financial transactions such as interest payments or the acquisition of funds through debt or equity financing.

As should be obvious, such a tax base would be easy to implement from an administrative point of view, since it relies solely on cash flows which are, in principle, readily observable. What may not be so obvious is that this base is equivalent in present-value terms to the economic rents of the firm. The reason for this is as follows. The economic rent base allows a deduction for accrued costs plus a cost of financing real capital on hand. For each of revenue and cost, there will generally be a difference between the flow of accrued costs and cash flows. However, because the cost of financing is being deducted, the present value of the accrued items discounted at the cost of finance will equal the value of the cash flows themselves.

This present value equivalence might be illustrated for the case of depreciable capital. Consider a machine that depreciates at the declining balance rate of δ. Let this rate include wear and tear as well as changes in the price of the asset. Suppose the real cost of finance is r. If \$1 is invested in the machine at time t=0, the undepreciated value of the asset remaining at time t will be $e^{-\delta t}$. This will be the replacement value of the asset remaining at that time. (We are using a continuous time format purely for convenience of exposition.) At time t, the firm will be allowed to deduct a depreciation rate δ applied to the replacement value of the capital stock, as well as a cost of finance r applied to the same base. Thus, at t, the full deduction for capital costs (depreciation and financing) will be $(r + \delta)e^{-\delta t}$. The present value of this discounted at the rate r is simply \$1, the original cost of the capital. The same applies to all other deductions. Thus, in present-value terms, deducting the \$1 original cost of the capital immediately is equivalent to deducting the financing and economic depreciation costs over time.

This present value equivalence means that, although the time profiles of economic rents and cash flows will differ, they will be the same in present-value terms. Thus, tax collections will be equivalent in present-value terms although their time profile will differ. This difference in time profiles is of no particular concern to economists; however, governments sometimes worry about it. In the case of the cash flow tax, since deductions occur up front, tax liabilities tend to be postponed into the future when compared with a rent tax. Indeed, they may well be negative in years of heavy investment. For the equivalence to hold, negative tax liabilities should be treated symmetrically with positive ones. Otherwise, the tax will not be neutral; in particular, it will discriminate against small growing firms and against risky investments. Indeed, another attractive feature of the cash flow base with full loss offset is its neutrality with respect to capital risk. Deduction of capital expenses as they occur avoids the improper

deduction of the cost of bearing capital risk, due to the use of depreciation based on *ex ante* costs.(See chapter 3 for a further discussion of this.) The implications of refunding negative tax liabilities and generally postponing tax liabilities into the future may trouble governments which are concerned with their own cash flows. Thus, on purely political grounds, the cash flow tax may be an idea whose time has not yet come.

The reluctance of governments to impose a cash flow tax in its pure form need not imply that a rent tax is not feasible. It turns out that there is a whole class of tax bases which are equivalent in present-value terms both to the economic rent base and to the cash flow base. We might term this class of tax bases the *modified cash flow tax*.[8] The modified cash flow tax builds upon the equivalence between the present value of cash flows and the present value of economic rents noted above. What it does is characterize in a more general way the set of all tax bases which have the same present value equivalence as a cash flow tax, and thus as a rent tax.

The simplest way to illustrate how this modified cash flow base operates is by considering the deductions allowed for a particular sort of expenditure, say the acquisitions of a certain class of capital goods. Suppose for this type of expenditures we define a write-off rate α, exactly analogous to a CCA rate. Using this write-off rate, we then define the undepreciated capital cost (UCC) of this capital good as the accumulated sum of past expenditures at historic cost that have not yet been written off. Thus, if I is the amount of investment undertaken at time s by the firm, the UCC of the capital stock at time t, denoted A_t, is defined as (again we use continuous time for convenience):

$$A_t = \int_0^t e^{-\alpha(t-s)} I_s ds.$$

Suppose now that the tax system allows as a deduction for the costs of this capital good the following two items: the write-off rate α applied to A_t and a cost of finance equal to the nominal cost of funds R applied to the same undepreciated cost A_t, so the total deduction for the capital is simply $(R + \alpha)A_t$. It can readily be shown that, under such a system, the present value to the firm of its deductions for some capital expenditure in this case is the initial expenditure on the capital.

This equivalence is readily demonstrated using the same sort of example as above. Consider an initial \$1 capital expenditure. If it is written off at the rate α, the undepreciated capital cost at time t is simply $\$e^{-\alpha t}$. The total deductions are therefore $\$(R+\alpha)e^{-\alpha t}$ at time t, and the present value of all future deductions is \$1. Notice that this will be true no matter what the write-off rate α is. It will also be true if the rate α varies over time in any arbitrary fashion. All that is

8 A technical analysis of this base may be found in Boadway and Bruce (1984).

required is that whatever the undepreciated capital cost, a nominal cost of finance R must be deducted against that full amount, independent of the actual interest payments of the firm. Notice that the cost of finance used should be a riskless one.[9] This scheme is also equivalent to indexing the CCA base A_t by the nominal cost of finance R. It should also be noted that if the firm is wound up, any remaining book value of undepreciated capital A_t should be eligible for a tax credit. The same should apply for takeovers.

This same principle can be applied to any component of the cash flow of the firm, be it current or capital. Furthermore, various items can be arbitrarily aggregated into a single class or category with the same α. Indeed, in principle, the firm might be allowed to choose any values for α it desired, and could vary them over time. Cash flow revenues could be treated symmetrically with expenses. This makes the tax system almost as easy to administer as the cash flow system itself. Effectively, the deductions for cash flow expenditures are being arbitrarily spread out over time in a way which retains its present value equivalence to cash flows. Furthermore, no indexing is required. The book values are based upon historic costs, and the financial write-offs are in nominal terms. Exploration and development and other expenditures unique to the resource industries can be treated like any other cash flows. They can be written off at any rate α when accompanied by the appropriate financial cost deduction. In short, neutral resource taxation is an easily achieved and feasible objective.

This is a general formulation of a neutral tax system with a tax base that is equivalent in present-value terms to rents. The choice of different patterns of α gives rise to different time profiles of tax liabilities. Given the choice, firms might prefer to choose α to be as high as possible, so as to take advantage of the financing assistance available through the tax system. However, as mentioned, the government may be reluctant to allow the full refundability of negative tax liabilities. To accommodate the joint desires of the firms to take deductions up front, and of the government not to refund negative tax liabilities, the system could allow a firm to select any time pattern for its α, subject only to the requirement that it never run negative tax liabilities. If a firm chooses to make its α as large as possible, subject to this constraint, it should be readily apparent that the tax system would be exactly equivalent to a cash flow tax system which, instead of making negative tax liabilities immediately refundable, allowed firms to carry forward tax credits with full interest at the rate R.

Allowing tax credits which are not refundable to be carried forward with interest implies that the modified cash flow tax allows the equivalence of full loss offsetting; that is, it treats negative taxes symmetrically with positive ones. This is a very important property of a tax system, for an industry with returns that are subject to random fluctuations. As shown in chapter 3, if a tax system

9 This was demonstrated in Fane (1987).

treats gains more harshly than losses, it will discourage firms from taking risk, will favour low-risk (low-return) investments, and result in inefficiency. It is therefore very important that this loss-offsetting property be part of the tax structure, especially for a high-risk industry such as mining. It will guarantee that the tax system treats risk in a neutral fashion, and will obviate the need for the government to introduce special incentive measures to assist risky industries.

The imposition of a rent tax, though feasible and simple to administer, is not the only way for the public sector to capture a share of resource rents from the private sector in a non-distortionary way. An alternative way would be to auction off to the private sector leases for the exploration and development of the resource. If such auctions functioned in a perfectly competitive way, and if all of those bidding on the resource have the same expected costs, the auction price of the rights would reflect the present value of future expected rents after tax and after accounting for a risk premium. In a sense, an auction captures *ex ante* rents while a rent tax captures *ex post* rents. This difference suggests that governments may not wish to rely entirely on auctions for the capture of rents. Auctions require that the firms pay their rent tax revenues up front, and that may be difficult. Furthermore, auctions will only capture expected rents; they will not capture windfall gains, including the unexpected gains or losses from government policy changes. Rent taxes, on the other hand, will include windfall rent changes. Finally, if one of the bidders has lower expected costs than the others, in a first-bid auction framework this producer will bid its expectation of the cost of the next less costly producer. In this case, the auction would not even capture all *ex ante* rents. Thus, governments may prefer to use a mix of auctions and rent taxes to garner their share of the rents.

Some other design issues might be mentioned here that bear on the relation between the rent tax and other taxes. First, there is no need for any integration of the rent tax with the personal tax system, as there might be with the withholding tax. To the extent that integration were effective, it would simply undo the effects of the rent tax.

Second, an interesting design issue arises with regard to the relationship between a rent tax and a corporate income tax: should one be deductible or creditable against the other. The tendency of the present system is to allow some deductibility of the resource tax, or something in its place (e.g., a resource allowance) against the corporate income tax. This would not be appropriate in a properly designed system. Deductibility of the rent tax against the corporate tax base, or crediting the rent tax against corporate tax liabilities, would serve to undo, at least partly, the taxation of rents. At the same time, it could be argued that either deductibility of the corporate tax from the rent tax or crediting of it against the rent tax is desirable. The reason is as follows. Given the existence of a distorting corporate tax, the imposition of a rent tax would impose no further distortions only if it allowed corporate taxes to be deducted from the

rent tax base. In the absence of these deductions, the rent tax would impose a further distortion over and above the one already being imposed by the corporate tax. However, an even better outcome can be achieved. If the corporate tax were credited against rent tax liability, and if the rent tax were always set such that its liabilities exceeded those on account of the corporate tax, the combined tax system would be non-distorting overall. That is, the crediting, if it were fully effective, would serve to nullify the distortion that would otherwise be imposed by the corporate tax. Thus, crediting would seem to be ideal. This prescription would, however, be contingent on the corporate tax liabilities still being creditable abroad by foreign firms against their tax liabilities abroad, and that may not be the case. As mentioned, it also requires that rent tax liabilities exceed corporate tax liabilities. In any case, it is clear that the current system is not appropriate.

There are also some purely administrative compliance problems with implementing a cash flow tax for rents that should be mentioned. In the case of multinational corporations, if one country has a cash flow tax while another does not, there will be an incentive for the firm to allocate costs to its operations in the taxing jurisdiction to reduce tax liabilities. These costs could include such things as overhead, distribution and shipping costs. In addition, there will be an incentive for the firm to issue its debt in jurisdictions where interest is deductible.

Finally, it is worth repeating that there are serious jurisdictional issues involved in designing a rent tax, as there are in corporate tax. To the extent that both the federal and provincial levels of government are entitled to a share of the resource rents, an agreement on sharing the revenues from a common base would be desirable. Presumably, this would be very difficult to achieve. In the constitutional sense, there is ambiguity in deciding the relative resource revenue shares of the various levels of government. The provinces' case is based on the fact that the Constitution gives control over resources to the provinces as well as the right to levy any tax they desire. At the same time, the Constitution does not limit the taxing powers of the federal government, which presumably could tax resources as well if it wished. In addition, the responsibility given to the federal government for equalization across provinces almost requires that the federal government have some access to resource revenues. No matter how the question of sharing is settled, a common tax base across provinces, based on rents, should be recognized as desirable on its own merits.

PROBLEMS WITH THE EXISTING SYSTEM

The details of the existing system of corporate and mining taxation were outlined fully in chapter 2. The purpose of this section will be to evaluate the current system against the "ideal" system of business taxation discussed above. The ideal system consists of two components. The first is a corporate tax levied

for withholding purposes; its base might be the equity income of all corporations operating in Canada, and the tax should be harmonized among all governments, provincial and federal. In addition to this tax, and separate from it, there should be a rent tax applying to the resource industries. It should also be harmonized across governments. The corporate tax system is discussed first below, followed by the system of mining taxes.

The Corporate Income Tax

The discussion concerning the design of the corporate tax indicated that there is no single ideal tax base for withholding, for two principal reasons. First, since the withholding is largely intended for foreign shareholders, especially those for which foreign tax credits are available, it might be beneficial for the domestic tax base to reflect the bases used abroad for crediting. Unfortunately, foreign tax bases are far from uniform. Second, the withholding unavoidably applies to domestic corporations as well; it is not feasible to undo this effect fully by a system of integration. Therefore, the revenue gains from withholding against foreigners must be set against the inefficiencies of distorting domestic investment decisions. One way to reduce the inter-sectoral and inter-asset distortions of the corporate tax system is to use a base which is as close as possible to true equity income. An unavoidable tax distortion will remain, but it will not vary systematically across types of investment, except to the extent that there are systematic differences between debt and equity financing of them. Since the differential treatment of debt and equity cannot be removed without sacrificing the withholding role, perhaps the best that can be done is to base the corporate tax on equity income. That is the view we take.

It should be clear that the measurement of true equity income is a very difficult task, if not impossible. It requires an ability to measure true economic depreciation, true depletion of resources, full indexation of all capital costs, and all the other difficulties that come with accrual accounting including the requirement that any cost be deducted only when it is actually contributing to the current generation of revenue. Thus, the tax base will never be a perfect reflection of equity income. Nonetheless, some of the blatant deviations of the existing system from equity income can be identified and corrected so as to reduce differences in effective tax rates across industries and types of capital expenditures. Many of these issues have recently been addressed in the tax reform of 1987, but many remain to be addressed, including some that are relevant to the mining industry. The following list shows the main examples, which are described below.

i. Capital cost allowances. The base for the CCA deduction uses the historic cost rather than the replacement cost of capital. To that extent, the deductions understate economic depreciation in times of inflation and incorrectly impute the cost of bearing capital risk. On the other hand, the actual rates themselves

are often much higher than the actual rates of wear and tear of the capital as judged by observed service lives and replacement expenditures. In addition, from time to time special accelerated CCA provisions have applied to certain types of investment. An example of this was the two-year write-off afforded to machinery and equipment in selected industries and the write-off of the cost of new mine assets up to the income for the mine, both of which were abolished with the 1987 tax reform. A related problem with the CCA deduction has been to ensure that it was available only on capital that was actually being used to produce output. This has been partially remedied by the institution of the put-in-use rule for depreciable capital expenditures.

ii. Inventories. Inventories, like depreciable capital, are currently costed on an historic (first-in, first-out) cost basis. When prices are rising, this reduces the cost of inventory deductions below their replacement cost. It should be noted that other countries, including the United States, allow firms to use last-in, first-out costing for inventory. As shown in chapter 3, effective tax rate calculations have indicated that relatively large disincentives are created for the holding of inventories by the existing corporate tax system. Prior to the tax reform, the 3 percent inventory allowance served as an (imperfect) substitute for replacement cost accounting for inventories, but no such measure now exists.

iii. Interest deductibility. Firms are allowed to deduct nominal interest payments from their corporate tax base. A true equity income base would allow only real interest payments to be deducted. The inflationary component of interest payments corresponds with the fall in the real value of the principal due to inflation. Therefore, it is equivalent to a partial repayment of principal rather than a required rate of interest. The ability to deduct nominal interest payments actually reduces the disincentive effect of the corporate tax during periods of inflation as well as exacerbating the advantages of debt financing over equity financing.

iv. Resource deductions. Firms are allowed several deductions for the use of resources. The cost of acquiring resource properties, exploration expenditures, and development expenditures are all written off very rapidly, in some cases immediately, regardless of when the resource is actually "put in use". In addition, mining resources have been afforded an additional deduction in the form of the earned depletion allowance against exploration and development expenditures, and investment in new mines and processing assets (although this allowance is being phased out by the current tax reform). This amounts to a double deduction for the use of these resources. As mentioned, a true equity income base would treat resource deposits exactly like inventory. There would be no deduction for the costs of acquiring the resource at the time the expenditures took place. Instead, deductions should take place only as the resource is being depleted and should be based on the replacement value of resources

depleted for revenue purposes. The consequence of the current treatment is that the tax base understates equity income to a considerable extent. As a result, revenues are not being withheld at source which perhaps ought to be, and some of the consequences of that could simply be flowing into foreign treasuries.

A related deduction is the resource allowance, which is intended to give some credit to the firm for the resource tax paid at the provincial level. If the resource tax is viewed as a tax intended to collect the public sector's share of the rents, this is an unnecessary deduction, and serves only to undo part of the purpose of the resource tax. In principle, the federal and provincial taxes should be quite separate taxes, levied independently of one another.

v. Other capital cost deductions. Several other expenditures of a capital nature are treated relatively preferentially by the tax system. These include research and development expenditures, manpower training, and marketing expenditures. In most cases, these would be very difficult to impute on an accruals basis, and most tax systems make no attempt to do so.

vi. The rate structure. The rate structure encompasses the statutory rates, the system of tax credits, and the treatment of negative tax liabilities. The Canadian corporate tax system consists of a general rate (which varies to some extent across provinces) as well as preferential rates to two types of firms: those involved in manufacturing and processing, and small businesses (Canadian-controlled private corporations). The result is different effective tax rates among firms, as well as some foregone tax revenues, perhaps to the benefit of foreign treasuries. There are two reasons why governments may engage in this sort of preferential treatment. One is for industrial policy reasons, such as to encourage the development of a manufacturing sector in Canada. To an economist, the benefits of such a policy are hard to see, since artificial tax incentives serve only to misallocate resources among their most efficient uses and cause losses to society. The reason for the small business incentive is probably somewhat different. It is often argued that small businesses should be given special incentives because they find it difficult to raise finance, relative to larger firms. This may be the case. However, if it is, it is not obvious that lowering the tax rate is of much assistance. Indeed, the cash flow of small firms will be helped much more by maintaining higher tax rates, allowing tax deductions to occur up front, and providing for refundability of tax losses, none of which the Canadian tax system does.[10]

The system of tax credits is dominated by investment tax credits, or was until the recent tax reforms when most of them were abolished. Like preferential tax rates, investment tax credits introduce differential effective tax rates on different investment decisions in the economy, favouring those which obtain the tax credit. In addition, they favour short-lived investments over long-lived ones, since the credit is applicable on gross investment rather than net. The current

10 This is discussed more fully in Boadway, Bruce and Mintz (1987).

tax reform has few tax credits for investment, the main ones being for investment in depressed areas and for research and development expenditures. Thus, this is no longer a major structural problem in the tax regime.

The final element of the tax structure, and one which leaves a great deal to be desired, is the loss offsetting provision. From the point of view of efficient risk taking, negative tax liabilities should be treated fully symmetrically with positive ones. This means either full refundability of tax credits or an indefinite carryforward with full nominal interest accumulations. The full refundability option has the additional merit of providing financing for the firm when it is most needed.

The existing system of loss offsetting comprises two components: carrying of tax losses forward and backward, and flow-through shares. The provision that allows firms to carry negative tax liabilities forward for seven years and backward for three is not comparable with full loss offsetting for two reasons: the carryforward is without interest, and it is of limited duration. The limited duration of loss carryforwards is mitigated by the fact that CCA deductions can effectively be postponed as long as a firm wishes, by not declaring them. The consequence is that the ability to offset losses varies across firms and is likely to affect relatively more adversely those firms involved in risky enterprises, especially smaller ones without the ability to pool losses across different lines of business. Furthermore, there will obviously be an incentive for firms to circumvent the restrictions by transferring their losses to profitable firms. Governments have resisted these attempts, viewing tax loss write-offs simply as losses in tax revenue, whereas the loss write-offs should be considered more as ways of making good negative tax liabilities to which the firms are entitled. There is a strong consensus among economists that extending the loss offsetting provisions to make them comparable with full loss offsetting would be beneficial on economic efficiency grounds by eliminating the discrimination that the current system causes against risk taking, especially by small and growing firms.

The second component of the existing system, and one which applies only to the resource industries, is the use of flow-through shares. As discussed in earlier chapters, mining and oil and gas firms which finance exploration and development expenditures by the issue of flow-through shares can flow their deductions through to the purchasers of those shares, who may apply them against their personal taxable income. The use of these shares provides some form of refundability of tax losses to resource firms, but does not correspond exactly with full loss offsetting: it applies only on losses generated by exploration and development expenditures; it applies only when those expenditures are financed by new share issues, which might otherwise not be the preferred method of financing; and the credits are calculated at the shareholder's personal tax rate augmented by an additional capital gains component from the zero cost base used for calculating the capital gain on the share for tax purposes rather

than using the corporate tax rate. Although the tax advantages of this form of financing may be considerable, it still does not constitute an ideal form of loss offsetting.

vii. Integration with the personal tax. The current tax system provides for partial integration of the corporate tax with the personal tax by a system of dividend tax credits applicable to dividends received by some shareholders. There are two issues here. First, if full integration is desired, the current system falls far short of the ideal; the main reason is that the dividend tax credit applies only to taxable dividends received, not to dividends received in tax-sheltered form, such as through pension funds or RRSPs. Given the volume of tax-sheltered equity assets, this is a major flaw in the system of integration. Another reason the integration is less than ideal is that the amount of the dividend tax credit is independent of the taxpaying status of the firm paying the dividend. In principle, the dividend tax credit rate should reflect the average tax rate withheld at the corporate level on dividends that are being paid out by the firm. This tax rate varies widely across firms and this is not reflected in the dividend tax credit rate. For example, dividends paid by a non-taxpaying firm are eligible for the dividend tax credit, even though no tax has been withheld at the corporate level. It would obviously be quite difficult to design a system in which the dividend tax credit exactly matched the taxes that had been withheld at source. Also, capital gains are not subject to integration at all. It could be argued that they should be since the income retained to generate the capital gain is subject to the corporate tax. On the other hand, the preferential personal tax treatment of capital gains is intended to compensate partially for this already.

Perhaps a more substantive issue is whether integration is desirable in the first place. We have argued above that, in an open economy in which rates of return on investment and savings must conform to those determined on world capital markets, integration measures applied at the personal level do not serve to undo the effects of the corporate tax on investment. Instead, they serve only to increase the rate of return to domestic savers. This constitutes a distortion on the capital markets which cannot be justified on equity grounds. The implication is that in a small open economy with highly open capital markets, integration can be counterproductive.[11] Only to the extent that Canadian capital markets are segmented, or if equity earnings are not perfectly elastic with respect to the risk-adjusted cost of equity, will some degree of integration be desired to avoid the double taxation of capital income.

In summary, the existing corporate tax system differs considerably from what we have argued is the ideal system. The base does not correspond to equity income, especially for resource firms. As a consequence, the tax introduces differential distortions on investment and expenditure decisions

11 The problem of corporate tax integration in a small open economy is analyzed in Boadway and Bruce (1988).

of various sorts, distortions which have been documented in earlier chapters using the concept of a marginal effective tax rate. There seems to be much scope for further improvement of the corporate tax system through tax reform.

Provincial Mining Taxation

The benchmark for evaluating provincial mining tax regimes is the rent tax in one of its equivalent forms. The characteristic feature of the rent tax is that it is fully non-distorting if properly designed. The opportunity cost of all inputs in the production process is deductible, so there is no tax incentive to change any production techniques. In other words, for the ideal rent tax, the marginal effective tax rate is zero, though, of course, the average effective tax rate will be positive if rents are being earned. As the previous section explained, it is administratively feasible for governments to design and apply a tax the present value of which is equivalent to rents. The simplest candidate is the cash flow tax accompanied by full loss offsetting. However, if the time profile of tax revenues generated by such a tax are unpalatable to governments, they can easily design a modified cash-flow tax with the same present value of tax revenues, but with virtually any time profile desired. For instance, governments could avoid negative tax liabilities altogether under such a tax base (except, of course, for the case in which the firm winds up with a tax credit owing to it for capital cost deductions not yet written off).

The existing system of mining taxation at the provincial level is clearly far from this ideal, as shown by the marginal effective tax rates presented in chapter 3. There it was found that marginal mining tax rates for most types of investment decisions by taxpaying mining firms were actually negative, indicating that the tax system effectively subsidized such investments. However, the rate of subsidy was not very large, either in absolute terms or compared with the corporate income tax. For non-taxpaying firms, the subsidy was smaller still because of the reduced value of write-offs to the firm, and, depending on the time profile of the loss position of the firm, the effective tax could become positive. These non-taxpaying firms are often those which one would least like to have the tax discriminate against. The existing mining taxes, therefore, are less than fully efficient collectors of rent. In addition, because different provinces apply different taxes to different types of minerals, the mining tax system distorts the intra-industry allocation of investment as well.

There are a number of reasons why mining taxes are distortionary. Although they are nominally based on income, the concept of income used differs considerably from economic income, largely because of the generosity of deductions allowed. Deductions for the acquisition of resources, exploration, and development are usually written off very rapidly, generally well in advance of the exploitation of the resource. In addition, depreciable capital is written off rather rapidly in general. The processing allowance, which typically de-

pends upon the original undepreciated value of capital offers a further deduction on capital. Special deductions are frequently given for exploration expenses. Against these advantages must be set the fact that financial costs are usually not deductible for mining tax purposes and indexed values are not used for inventory write-offs or for CCA. On balance, the advantages of the rapid write-offs tend to offset the disadvantages of the lack of both interest deductibility and indexation, so that the marginal tax rates are negative. But, as mentioned, much depends upon the circumstances of the firm, particularly whether or not it is in a loss position, since mining taxes do not offer full loss offsetting. In the mining sector, the intra-industry distortions of the provincial tax may be as important as the broader effect on mining relative to other sectors (see the discussion in chapter 3).

It is instructive to compare the effects of provincial taxation of mining with those of provincial taxation of oil and gas. Unlike mining taxes, which tend to be based on some notion of income, a good part of oil and gas revenues come from royalties. From an economic point of view, royalties are essentially like taxes on production or revenues with no deductions for costs. Because of this, marginal tax rates tend to be strongly positive, indicating a strong disincentive effect of the tax. For example, a recent study showed that effective royalty rates were as high as 54 percent on exploration and development and 7 1/2 percent on depreciable capital investment for conventional oil and gas in Alberta.[12] Thus, the need for provincial tax reform in mining may not seem as urgent as in oil and gas. Note, however, that royalties do not distort the firm's decision regarding choice of technique of production; that is, the choice of more or less capital-intensive techniques. The mining tax does, however, influence the choice of capital-labour ratio.

SUGGESTIONS FOR THE REFORM OF THE TAXATION OF MINING

Directions for beneficial tax reform are implicit in our above discussion of the ideal tax system and the problems with the existing one. This concluding section can, therefore, be regarded as summary in nature. A precondition for successful and rational tax reform is a recognition of the precise roles that particular taxes are best suited to perform. Our suggestions for reform are made in the context of our idealized assignment of roles and, given those roles, the ideal form that the taxes should take. Neither the roles themselves nor the ideal tax structures are well defined. Some judgment is involved in both. For example, in the case of a tax designed for withholding, there is no single uniquely ideal tax base, since the same tax must be used for withholding from many different sources, each of which would ideally call for its own unique tax base. Furthermore, since

12 See Boadway and McKenzie (1988).

any tax which withholds against foreign shareholders inevitably also distorts domestic investment decisions, there is an inevitable trade-off involved in choosing the withholding tax base. Other tax specialists may well disagree with the particular way we have chosen to resolve this trade-off.

To reiterate, mining taxation should not be viewed in isolation from other business taxes, particularly the corporate income tax, if only to settle on the allocation of responsibilities imposed on each type of tax. In our view, business taxation has two main functions. The first is a withholding function: business taxation is a device for withholding capital income at source that would otherwise escape full taxation at the personal level. In a highly open economy, this role involves mainly withholding against foreign shareholders. We view this as the primary responsibility of the corporate tax and would design it accordingly. The second function is the collection of rents generated by private sector production activities. This function we would assign to sector-specific taxes in those sectors where rents are likely to accrue; the provincial mining taxes would be examples. It is important to note that these two roles call for essentially different taxes, so two separate tax systems are required.

According to this view, neutrality of the tax system is a property of the second tax, but not necessarily of the first. However, the distorting effect of the withholding tax can be mitigated, or eliminated entirely, in those industries subject to a rent tax, if the withholding tax liabilities can be credited against rent tax liabilities. Furthermore, in an open economy setting, a good case can be made that the withholding and rent taxes should be effectively quite separate from personal taxes. In such a setting, it can be argued that, since rates of return on savings and investment are essentially predetermined by international capital markets, integration of the corporate and personal tax systems cannot undo the distorting effect of the corporate tax on domestic investment. Furthermore, integration of taxes levied for the purposes of collecting rents would be counterproductive in any case. Our reform suggestions take these arguments into account.

There is a further set of problems that arises in a federal state such as Canada, and that concerns the appropriate roles of the federal and provincial governments in business taxation. The issues concern both the harmonization of taxes that may be levied at both levels of government and the sharing of the revenues. There are no hard and fast rules to answer these questions, least of all constitutional ones. A case can be made that business taxes in both the withholding and the rent-sharing roles should be co-occupied by the two levels of government.

The corporate tax is already explicitly co-occupied by the federal and provincial levels of government. The Tax Collection Agreement serves as a device for dividing up the corporate tax room between the two levels of government as well as for harmonizing the corporate tax bases across participating provinces and to a large extent among the non-participating provinces as well. It also serves to implement the formula for allocating taxable income

across provinces earned by firms which operate in more than one province. This arrangement has obviously worked well, despite the fact that three provinces have opted out. Indeed, it could be looked on as a model of tax harmonization, the likes of which exist in few federal states. A reformed corporate tax designed as a pure withholding device could, and should, continue to operate under the Tax Collection Agreement as well.

The case for rent tax is not so well established. As mentioned earlier, the reformed Constitution effectively assigns "ownership" and control of nonrenewable resources to the provinces, including the right to levy taxes of their choice. They exercise this right by imposing their own regimes of mining taxation and oil and gas royalties. This does not necessarily imply that they are entitled to all the revenues from resources, though admittedly it is a matter of interpretation. For one thing, the federal government is given unlimited rights to taxation by the Constitution and this could be interpreted as applying to resource rents as well. Furthermore, there is in the Constitution a responsibility imposed on the federal government to make equalization payments to the provinces so as to allow them to provide comparable levels of provincial public services at comparable rates of provincial taxation. This constitutional prescription also accords with the economic analysis of federal grants widely accepted by the economics profession.[13] As noted previously, one of the main sources of differences in provincial tax capacity is due to differences in resource endowments, and it would be difficult to imagine the federal government fulfilling its constitutional obligation to equalization satisfactorily without some access, direct or indirect, to revenues from resources. On these grounds, federal sharing of resource revenues could be justified. Again, conventional economic analysis of federal-provincial grants supports this view.

One way to achieve a degree of federal access to resource revenues would be through a Tax Collection Agreement in the area of resource taxation. There would be several advantages to such an approach. In particular, it would serve to harmonize resource tax bases across jurisdictions. Currently, as we have seen, tax bases differ considerably across provinces as well as across types of resources, and this leads to tax-induced distortions in resource activity. In addition, it would serve as a device for dividing the tax room between the federal and provincial governments. By giving the federal government direct access to a share of resource rents, it would prevent them from using other, less efficient, ways of obtaining a share. In the past, these have included such instruments as indirect taxes, export taxes, and reforms of the corporate tax system. The federal government has also resorted to direct price controls as a means of diverting rents from the provinces to the consuming public.

13 A representative analysis of this may be found in Economic Council of Canada (1982).

A tax collection agreement in the area of resources would not be easy to implement. It would require a great deal of agreement and goodwill among the various governments. Presumably, such an agreement would have a somewhat different form than the arrangements for income taxation, where the provincial governments essentially buy their way into the Tax Collection Agreement by having the federal government collect personal and corporate taxes on their behalf in return for agreeing to abide by the federal tax base. This explicitly gives the federal government the unilateral power to determine the tax base and to make changes without consultation with the provinces. This has always been a source of some concern to the participating provinces. The income tax arrangements presumably exists in part for historic reasons going back to the years of World War II, when the federal government assumed full control of income taxes, and in part because the federal government has assumed a dominant (but declining) share of the corporate and personal income tax revenues. The case with resource taxation is somewhat different. Here, the tax share of the provinces is higher than that of the federal government, and their prior claim to occupancy of the tax field is stronger. A tax collection agreement would have to recognize this by giving the provinces a much stronger role in determining the base and any base changes, while at the same time harmonizing the bases across provinces and resources. Similar sorts of issues are likely to arise over the harmonization of sales tax bases as the federal government attempts to replace the existing Manufacturers Sales Tax with a National Sales Tax. Here, too, the provinces are likely to want a larger say in determining the base.

Let us finally turn to the sorts of tax reform measures which would be compatible with the roles that we have ideally assigned to the components of the system of business taxation. Since, as we have argued, the withholding role of the corporate tax is quite separate from the rent-collecting role of the mining taxes, each type of tax can be dealt with separately, beginning with the corporate tax.

Reform of the Corporate Tax

The corporate tax is in the midst of a rather major reform, under which the base is being broadened and the rates lowered. The base broadening involves the elimination of some tax preferences and generally serves to move the system towards more uniform impact across investment activities. It also moves the system in the direction of a tax on equity income, although not all the way. The specific measures being implemented during the reform include the following:

- the elimination of accelerated (two-year straightline) CCA rates for machinery and equipment;
- the reduction in certain CCA rates, some of which apply directly to resources, including a reduction in CCA rates from 30 percent to 25 percent for

extraction assets and a reduction from 5 percent to 4 percent for offsite buildings;

- the institution of a put-in-use rule for depreciable assets;
- the elimination of the inventory allowance;
- the elimination of earned depletion;
- the retention of flow-through shares, but with less generous provisions;
- the capitalization of the soft costs of real estate development.

In addition, certain rate structure changes will have a bearing on the distortionary effect of the tax system, including the general reduction in rates, and especially the elimination of the investment tax credit.

These reforms go some way to reducing the uneven impact of the tax system as reflected in marginal effective tax rate estimates illustrated in chapter 3, and to moving the system in the direction of a tax on equity income. However, a number of discrepancies persist, many of which apply to the mining industry. Some of the potential measures that could be taken in future tax reforms to move the corporate tax system closer to one on equity income include the following:

i. Indexation. All capital assets written off on an accrual basis should be done so on a replacement-cost basis. This includes the depreciation of machines and buildings (CCA), the cost of using inventory, and the costs of depleting resources. The absence of replacement cost accounting will imply that the corporate tax base overstates true equity income. On the other hand, indexation should also apply to the deduction of interest costs. Only real interest costs should be deductible, and not nominal ones.

ii. Capitalization of the costs of acquiring and using resource properties. If resource assets are to be treated in a comparable way with other assets, and according to a tax base which corresponds with equity income, they should be deductible only on an accrued-cost basis. This means that only when they are depleted and used to produce revenue should they be deducted. Essentially this involves treating resource properties exactly like inventory. No deductions should be allowed for the costs of accumulating these assets up front, whether they be the purchase of property rights or exploration and development.

iii. Extension of the put-in-use rule. The put-in-use rule, according to which deductions for CCA should only begin once the assets are actually put to use in producing revenues, should be extended to all sorts of capital assets, including resource properties. In principle, this and the capitalization provision above should also apply to such things as research and development, marketing costs, and manpower training, although these latter may be practically more difficult to implement.

iv. Full loss offsetting. All negative tax liabilities should be treated symmetrically with positive ones in order to avoid discouraging risk-taking. This is presumably a rather important provision from the point of view of the mining

industries, where investment costs are rather large and revenues are subject to large fluctuations over time. Ideally, the system of loss offsetting should provide for full refundability of tax losses, since this serves as a useful device for assisting in the financing of small and growing firms (much more effective than, say, preferential tax rates). In the absence of full refundability, tax credits should be allowed to be carried forward indefinitely with interest. Our analysis shows clearly that the use of flow-through shares is not a perfect substitute for full refundability (though it is presumably preferable to no provision at all). Nor is it possible to obtain the equivalent of full refundability using flow-through shares. Part of their distortion could be removed by increasing the cost base for capital gains tax purposes to the value of conventional shares, but since their tax savings are based on personal rather than corporate tax rates, they cannot be perfect substitutes unless those rates are equal. Furthermore, there is the disadvantage of requiring financing by new share issues, as long as capital gains are treated more favourably than dividends under the personal tax system (which brings us to one of the more controversial implications of our analysis, the relation of the corporate tax system to the personal one). Note that with full loss offsetting, income risk is effectively deductible. There is no simple way to deal with capital risk, other than through a full cash flow tax system. This is because capital risk involves changes in the value of capital held by the firm, and this is very difficult to measure.

v. Integration provisions. If one views the Canadian economy as being a highly open, with well functioning capital markets and a free flow of capital into and out of the country, this has seemingly strong implications for the effects of integration provisions working through the personal tax system. It implies that the effects of integration (i.e., the dividend tax credit) serve only to subsidize Canadian saving, and do so in a discriminatory way. The dividend tax credit does not undo the effects of the corporate tax on domestic investment decisions. Integration would accomplish this only if it applied at the corporate level, but it cannot be applied there without at the same time negating the withholding effects of the tax on income accruing to foreigners. The conclusion seems to be that the dividend tax credit plays only a limited role in the economy as a device for undoing the double taxation of capital income; instead, it distorts the market for savings.

Reform of Provincial Mining Taxation

We have already suggested that harmonization of mining tax bases is one highly desired element of mining tax reform. Here, we simply consider what the harmonized base should look like. The additional question of what rates should apply to the base and how the revenues should be shared between the two levels of government are essentially non-economic questions; the answers depend upon subjective views about ownership of property rights to the resources, and

to what extent the fruits of those property rights ought to be reallocated from the provinces that are well endowed to the others.

The choice of a tax base for collecting economic rents is now well established in the literature, and relatively simple to implement. As we have discussed, it comes in several equivalent forms. The most straightforward one, and the one which many economists would recommend, is the cash flow tax according to which all non-financial revenues and costs enter the base on a cash basis. The most controversial attribute of such a system is that it must fully refund negative tax liabilities. Such a system avoids all the administrative problems of measuring costs on an accruals basis and of indexing. It is neutral towards risk-taking and the refundability provisions contribute to the financing of small and growing firms. To an economist, it is an ideal tax, but it is rarely observed in practice.

One reason for the reluctance of policy makers to use the cash flow tax concerns its revenue implications over time. The cash flow base is fairly volatile. The implied variability of revenue collections might actually be viewed as an advantage by resource firms, because of the risk-reducing and financing benefits implied. Government is effectively absorbing part of the risk of the firm and at the same time providing financing at times of negative cash flows. However, governments may prefer not to assume the risk associated with such a variable tax base, shortsighted though that may seem to economists.

There is no published evidence of the variability of cash flows by firm, and detailed data are not available to us to calculate such cash flows. However, we have been able to compute aggregate cash flows for the resource industries for a series of years, using aggregate income flows reported in the Statistics Canada annual publication entitled *Corporation Taxation Statistics* for the years 1974 to 1984. The results are reported in table 20. The table confirms that, in the aggregate, there is considerable variability in cash flows over time with specific industry sectors. Mining cash flows tended to be positive in the 1970s and negative in the 1980s, reflecting in part the depressed state of metal prices in recent years. Over the entire period, the present value in terms of 1974 dollars was positive, indicating that governments could have obtained some positive revenues from a cash flow tax. A similar picture exists for oil and gas. Cash flows were negative during the period 1979-81 and have been strongly positive since, reflecting the movement of oil prices to the industry. Again, the present value of cash flows during the period is positive.

Although over the longer run governments will tend to gain positive tax revenues from a cash flow tax, there will also be periods of negative tax revenues. If, for whatever reason, governments cannot accept the revenue consequences of cash flow taxation, there are other alternatives available which can accomplish the same objective in present-value terms, and which simply change the time profile of revenues. In general terms, this requires that any costs can be amortized rather than expensed. The amortization can be at any rate, and

that rate can vary by type of expenditure (capital or current) as well as over time. The only requirement is that, for any cost which is amortized, a cost of financing must also be deductible by applying a nominal interest cost to the remaining book value of the amortized cost, where the book value is calculated using the amortization rate being used. (Equivalently, instead of an explicit interest deduction, the book value of assets for tax purposes could be indexed annually at the current nominal rate of interest.) This is also very easy to implement, but the full liquidity advantages of a cash flow tax to the private sector would be lost.

If the only concern of the government is to avoid refunding negative tax liabilities, the above system can take a very simple form. It can basically be a cash flow tax with the proviso that negative tax liabilities be carried forward indefinitely with full interest accumulations using nominal interest rates.

Moving the existing mining tax systems towards one of these neutral rent systems, be it cash flow or a modified version of cash flow taxation, should be a fairly straightforward matter. The system could be phased in for new expenditures by allowing them to be expensed or amortized as desired. The mechanics of doing this is relatively straightforward. The political consensus and cooperation will be much more difficult to achieve.

Appendix A

THEORY AND METHODOLOGY

In order to restrict the bulk of the text to a discussion of the important issues, and avoid bogging the reader down in excessive technical detail, the discussion in the text is kept on as intuitive a level as possible. The specific details of the equations which underlie the discussion have been provided in this appendix. In presenting the theory a "two-pronged" approach is adopted. First, the theory underlying the estimation of marginal effective tax rates for the mining industry is presented in a rather informal manner, for those who want to understand more about the methodology but wish to avoid excessive technical detail. This is followed by a more formal derivation of some of the equations for those who are inclined towards somewhat more rigour. Even here the expressions are derived for relatively simple, stylized tax systems and ignore the specifics of the various mining tax regimes discussed in Chapter 2. Formulae for the various types of capital incorporating more of the specific provisions of the regimes are presented in the third part of the appendix.

I. Heuristic Development

1. The User Cost of Capital

As discussed in chapter 3 of the text, to measure effective tax rates it is necessary to estimate the gross of tax rate of return on marginal projects (r_g). To do this directly, it would be necessary to identify marginal investments and measure their rate of return. Of course this is not possible. Instead, we infer what r_g must be by obtaining a measure of the costs that the rate of return must just cover for the project to be profitable. To do this, we appeal to the neo-classical theory of investment. This theory postulates that firms will accumulate capital assets (undertake investment expenditures) until the revenue generated by the last increment of capital over a period (the marginal revenue product) is just equal to the cost of holding the capital over the same period (the user cost of capital).[1] If we think of the marginal revenue product net of economic depreciation and risk as the gross rate of return, then in equilibrium this must be equal to the user cost of capital net of depreciation and risk. We may use the user cost of capital (which consists of variables that we can observe or estimate) as a proxy for the required gross rate of return on a marginal investment.

1 For current expenditures a factor is hired to the point where the marginal revenue product is just equal to the cost of the input.

We begin the analysis by assuming that there is no risk or uncertainty (or, equivalently, that the firm is risk-neutral and makes all decisions based only upon the expected value of relevant variables). We relax this assumption later on, when we examine the impact of the tax system on risk-taking explicitly.

In the absence of taxes, the user cost of capital for depreciable assets consists of the cost of financing the marginal investment in real terms plus the economic rate of depreciation (due to wear and tear, obsolesence and capital gains). Therefore, for the marginal capital investment project,

$$MRP = r - \pi + \delta \qquad (1)$$

where

MRP = marginal revenue product of \$1 of investment (net of operating costs)
$= (P - C') \cdot MP_k/q$

where P = price of a unit of output sold

C' = marginal current cost of producing a unit of output

MP_k = marginal product of capital[2]

q = price of a unit of capital goods

r = weighted average marginal cost of funds
$= \beta i + (1 - \beta)\rho$

where β = proportion of investment financed by debt

i = nominal interest rate on debt (risk-free)

ρ = nominal required return to equity (risk-free)[3]

π = expected rate of inflation

δ = economic rate of depreciation

Equation (1) is the optimal marginal condition for the accumulation of physical capital. It states that the firm will continue to acquire capital until the cost of holding the last dollar of capital is just equal to the income it generates. The cost of holding the capital is equal to the real rate of return foregone by holding the capital instead of investing the funds elsewhere ($r - \pi$), plus the decline in the value of the capital due to (economic) depreciation (δ). As

2 The marginal product of capital is the derivative of output with respect to capital ($\partial Q / \partial K$).

3 In the absence of taxes, capital market equilibrium requires that the return on equity be equal to the (risk-adjusted) return on debt (i.e. $i = \rho$).

discussed in chapter 2, economic depreciation consists of the sum of actual physical depreciation less changes in the real value of the capital due to capital gains. Anything that increases the marginal cost of holding the capital *relative* to the associated marginal revenues, will decrease the incentive to accumulate physical capital and lower investment.

A similar type of marginal analysis may be applied to any type of expenditure decision made by the firm, such as the decision to undertake exploration and development expenditures. To simplify the analysis we assume that expenditures on exploration and development are current in nature, giving rise to reserves immediately which are then depleted gradually to generate current income. As is discussed in chapter 3, a more complicated representation of the process of exploration and development incorporating lags, uncertainty and the "capital" nature of these expenditures would not alter the analysis qualitatively. For exploration and development, the marginal condition analogous to (1) is:

$$MRP = w \qquad (2)$$

where w is the marginal cost of a unit of exploration and development (which, for simplicity, is assumed to be constant), and MRP is now the marginal revenue product of exploration and development, or the value of additional resources discovered per dollar of exploration and development.

As in equation (1), it is optimal for the firm to continue to undertake expenditures on exploration and development until the marginal revenue generated by the last unit of expenditure is just equal to its marginal cost. In this case the marginal cost is merely the market cost of an incremental unit of exploration and development, as these expenditures are assumed to be current in nature. Anything that increases the marginal cost of exploration to the firm *relative* to the associated marginal revenue will decrease the incentive for the firm to engage in exploration and development.

A similar condition may be developed for inventories. If we assume that inventories lower production (processing) costs by smoothing the production process, then the optimal marginal condition for holding inventories is:

$$MRP = r - \pi \qquad (3)$$

In the case of inventories, if we ignore unit storage costs and any real changes in the value of the inventory, the opportunity cost of holding a dollar of inventory over a period of time is equal to the real cost of funds. This is the income foregone by using funds to purchase (or produce) inventory rather than investing them elsewhere. If the opportunity cost of finance increases relative to the marginal benefit of holding inventories, then the firm will decrease its level of inventory holdings.

The final decision of mining companies we consider is their decision to extract depletable resources. In this case the appropriate marginal condition is the well known "Hotelling Rule", which is expressed as follows:

$$\frac{\dot{P} - \dot{C}'}{P - C'} = r - \pi \qquad (4)$$

where P is the (real) price of a unit of the resource, C′ is the (real) marginal cost of extracting a unit of the resource, and a dot above a variable represents its derivative with respect to time (i.e., $\dot{P} = \partial P / \partial t$). Thus $\dot{P}$ and $\dot{C}$ are the increases in the price and in the marginal cost of extracting a unit of ore in each period t.

The left-hand side of equation (4) represents the rate of increase in the (net of extraction costs) value of a unit of the resource over time. It can be thought of as the (real) capital gain accruing to the resource. It is the marginal benefit of holding the resource instead of extracting and selling it. The right-hand side of the equation is the real cost of finance at the margin. It represents the opportunity cost of leaving the resource in the ground, as it is the loss in income from not extracting the resource and investing the funds elsewhere and earning $r - \pi$. If the rate of increase in the value of the resource is greater that the opportunity cost of foregone investments then it is optimal to leave the resource in the ground, and of course vice versa. Equation (4) thus determines the optimal rate of extraction of the resource. If the opportunity cost of funds increases *relative* to the rate of increase in the value of the resource, then the rate of extraction should be increased.

2. The Impact of Taxes: Fully Taxpaying Firms

Consider now the effect of taxes on these optimal marginal conditions. The question we are interested in answering is to what extent do the income and mining tax regimes described in chapter 2 influence the optimal investment and expenditure decisions of mining companies? We begin by considering the federal income tax, a representative provincial income tax system and a simple representation of a provincial mining tax regime. More complete formulae showing the impact of the individual regimes discussed in chapter 2 are presented in section III of this appendix.

We consider first the case of a fully taxpaying firm. In this case the firm is assumed to be taxed immediately on all income generated by expenditures and is able to make full use of all credits and deductions as they arise. Any losses generated by the marginal investment are assumed to be written off against income from inframarginal investments or carried back for a reduction in past taxes and an immediate refund. This case may also be thought of as mimicking a full loss offset tax system. We also maintain the assumption of perfect certainty.

Formulae are presented below for very general types of expenditures, such as depreciable assets or exploration. Expressions corresponding to more specific types of capital classifications, such as processing or new mine assets, grassroots exploration or pre-production development, etc., are given in section III of this appendix.

Taxes influence the above equations, and thus the firm's investment and expenditure decisions, in two ways. First, by taxing revenues, they lower the marginal revenue stream (the left-hand side of the equations). Second, by allowing the deduction of various costs and granting credits, the tax system lowers the cost of making expenditures and holding capital (the right-hand side of the equations). The net effect is a combination of these two.

To see the general idea, suppose that A is the *present value* of all tax credits and deductions generated by $1 of investment in physical capital. This is the present value of the tax saving due to the tax deductions and not the deductions themselves. The after-tax purchase price of the asset is (1 - A). For simplicity, say there is no deductibility of interest for tax purposes, and assume that the income generated by the capital is taxed at the rate U. The after-tax marginal revenue product is then MRP (1 - U). Optimality requires that the net of tax marginal revenue product equal the net of tax cost of holding a dollar of capital, or that $MRP(1 - U) = (r + \delta - \pi)(1 - A)$. This is how taxation affects the optimal marginal conditions for firm investment in physical capital. The right-hand side of the expression is the cost of holding a dollar's worth of capital net of the savings due to the tax deductions. The left-hand side is the after-tax marginal return to the investment. The net impact of taxation may either encourage or discourage the accumulation of capital. We now go into somewhat more detail and look at some of the specific features of the tax code discussed in chapter 2.

For depreciable capital, the after-tax analog to equation (1) for a fully taxpaying firm is:

$$MRP\ (1 - U) = (R - \pi + \delta)(1 - A_1 - A_2 - A_3) \qquad (5)$$

where,

R = after-tax nominal (riskless) cost of finance
= $\beta i(1 - u_f - u_p) + (1 - \beta)\rho$[4]

4 Given our open economy assumption, if investors in the United States are the "marginal" investors in Canada, then capital market equilibrium requires that the after tax rate of return on equity equal the after-tax rate of return of debt. This means that:

$$\rho = \frac{i(1 - m)}{(1 - c)}$$

where m and c are the personal tax rates on interest and equity in the United States.

u_f = statutory federal corporate income tax rate

u_p = statutory provincial corporate income tax rate

u_m = statutory provincial mining tax rate

U = combined effective statutory tax rate on the marginal revenue stream[5]
$= U_f + U_p + U_m$

U_f = effective statutory federal tax rate
$= u_f (1 - \sigma)$

σ = federal resource allowance rate

U_p = effective statutory provincial tax rate (differs among provinces)

U_m = effective statutory mining tax rate (differs among provinces)

A_1 = present value of federal income tax deductions on a $1 expenditure

A_2 = present value of provincial income tax deductions on a $1 expenditure

A_3 = present value of provincial mining tax deductions on a $1 expenditure

Dividing (5) by (1 - U) gives the following expression, where the right-hand side is the user cost of physical capital adjusted for taxes:

$$MRP = \frac{(R - \pi - \delta)(1 - A_1 - A_2 - A_3)}{(1 - U)} \qquad (6)$$

Consider the numerator of equation (6) first. The first component ($R - \pi + \delta$), is the net-of-tax real cost of finance plus depreciation. It is lower than the real cost of finance and depreciation in the absence of taxes due to the deductibility of interest on debt for income tax purposes, which lowers the effective interest rate on debt to $i(1 - u_f - u_p)$. Note that interest is not typically deductible for mining tax purposes.[6] Moreover, the cost of equity finance is not deductible from either the income or mining tax. This implies that *all else being equal* the income tax system tends to favor debt over equity finance.

Although other considerations, such as agency and bankruptcy costs, imperfect loss offsetting, and personal taxes, may tend to limit the use of debt by corporations, the deductibility of nominal debt interest costs provides a definite incentive to undertake debt finance.[7] We do not deal explicitly with the firm's

5 Note the distinction between a (marginal) effective tax rate, described conceptually above, and the net effective statutory rate. The latter refers to the "net" statutory rate after various adjustments, such as the resource allowance for federal tax purposes.

6 Interest is deductible from the mining tax base in British Columbia. Manitoba grants a financing allowance in lieu of interest deductibility.

7 As discussed in chapter 2, the deductibility of *nominal* rather than real interest actually implies the deduction of a portion of the debt principle. This further encourages the use of debt finance.

choice of capital structure here, assuming that a given portion of all investment is financed by debt (β). This can be justified by assuming that interest costs increase with the debt/equity ratio. If this is the case, the financing decision is separable from the investment decision, with firms choosing the minimum-cost debt/equity mix first and then determining their optimal amount of capital (see Boadway, Bruce and Mintz (1987, p. 44). For further discussion of the issue of capital structure, see Bartholdy, Fisher and Mintz (1987) or Turnbull and Aivazian (1985).

The second component in the numerator of equation (6), $(1 - A_1 - A_2 - A_3)$, is the effective purchase price, or after-tax cost, of a dollar of physical capital. As discussed above, the effective cost to the taxpayer of a unit of capital is the actual price less the tax value (in present-value terms) of the various deductions and credits available for the asset. As discussed in chapter 2, the cost of acquiring depreciable capital is deducted over time through the deduction of prescribed capital cost allowances (CCA). Also, before 1986, most capital was eligible for investment tax credits. The price of a unit of capital is reduced in equation (6) by the present value of these credits and deductions. Thus A_1 is equal to:

$$A_1 = \phi + (1 - \phi)\ Z_f\ u_f\ (1 - \sigma) \qquad (7)$$

where

ϕ = ITC rate

Z_f = present value of federal CCA deductions, discounted by R
$= \alpha_f / (\alpha_f + R)$

where α_f = the (declining balance) CCA rate[8]

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8 This is determined as follows. If the CCA rate is α, then the present value of the depreciation deductions on a $1 expenditure is:

$$Z = \int_0 \alpha e^{-(R+\alpha)t} dt = \alpha/(R + \alpha)$$

In the empirical estimates we approximate the impact of the half-year rule as follows:

$$Z = \alpha/2 + \frac{(1 - \alpha/2)}{(\alpha + R)(1 + R)}$$

Appropriate adjustments are also made for straightline classes. For example, if an asset is written-off in equal increments of (1/T) over its life (T), the present value of the deductions is:

$$Z = \int_0^T e^{-Rt} (1/T) dt = \frac{1 - e^{-rT}}{rT}$$

Note that u_f is reduced by one minus the resource allowance rate. This reflects the reduction in the resource allowance base by the CCA claims. The net result is a decline in the value of CCA deductions (as every dollar claimed in CCA reduces the resource allowance by twenty-five cents). Also, as discussed in chapter 2, the value of CCA deductions is reduced by the investment tax credit. This is reflected in equation (7) by multiplying the present value of the CCA deductions (Z_f) by one minus the investment tax credit rate ($1 - \phi$).

By way of example, consider the federal income tax treatment for a Class 10 asset under the 1985 tax rules. The CCA rate (α_f) would be 30 percent; the asset may have been eligible for a 10 percent ITC (ϕ); the statutory federal corporate tax rate (u_f) was 36 percent; and the resource allowance rate (σ) was 25 percent, resulting in an effective statutory federal rate (U_f) of 27 percent [$U_f = .36 (1 - .25) = .27$]. Ignoring the half-year rule and using a discount rate ($\Re$) of 10 percent, the present value of the CCA deductions (Z_f) is .75 [$.3 / (.3 + .1)$]. The present value of the federal income tax deductions for a $1 expenditure on a class 10 asset would thus be 28.23 cents [$A_1 = .1 + (1 - .1) .75 \cdot .36 (1 - .25)$].

The effective price of a dollar of capital in equation (6) is also reduced by tax savings due to deductions allowed for provincial income tax purposes (A_2). As discussed in chapter 2, the income tax regimes vary slightly across provinces. In most of the provinces, the present value of tax deductions on a $1 expenditure on depreciable capital is determined in exactly the same way as for federal case except that they are multiplied by the appropriate provincial income tax rate. Thus, the present value of provincial deductions for depreciable capital would be something like the following:

$$A_2 = (1 - \phi) Z_f u_p (1 - \sigma) \qquad (8)$$

Note that most provinces utilize the federal CCA system, thus the use of the present value of federal CCA deductions (Z_f) in equation (8). Moreover, although most provinces do not grant their own investment tax credits, CCA deductions for provincial income tax purposes are reduced by the federal investment tax credit (as all provinces under the Tax Collection Agreement use the corporate tax base). Also, some provinces (Saskatchewan, Alberta, British Columbia) have special rules which effectively eliminate the resource allowance (σ), and allow provincial mining taxes and royalties to be deducted from the provincial income tax base instead. The formula is then altered slightly, as is shown in section III of this appendix.

Finally, the after-tax cost of a dollar of physical capital is also reduced by the present value of deductions allowed by the relevant provincial mining tax system (A_3). It was evident in the discussion of chapter 2 that these regimes vary considerably across provinces. Here the value of A_3 for a representative regime will be shown. Section III at the end of this appendix contains a complete set of formulae for various types of capital in all of the provinces modeled.

Consider a mining tax system where the only deduction allowed for physical capital is a depreciation deduction calculated on a declining balance basis. Moreover, assume that the processing allowance granted for expenditures on assets used in the processing of raw ore is constrained by the maximum allowable amount (say 65 percent of income). This has the impact of effectively lowering the mining tax rate to $u_m(1 - .65)$. Using reasoning exactly analogous to that used to determine the present value of federal and provincial income tax deductions, A_3 in equation (6) would have a value of:

$$A_3 = Z_m u_m (1 - \psi) \qquad (9)$$

where

Z_m = present value of depreciation deductions for mining tax purposes
$= \alpha_m/(\alpha_m+R)$

where α_m = declining balance depreciation rate[9]

ψ = processing allowance maximum (i.e., .65)

The numerator in equation (6) represents the cost of holding depreciable capital. We have shown that various deductions and credits granted by the income and mining tax systems reduce this cost. Of course, this is not the only impact that taxes have on the capital accumulation decision. The revenue stream generated by the marginal expenditure in depreciable capital is also taxed, thus lowering the return to the capital. This is represented in the denominator of equation (6). It represents the net of tax value of $1 of operating income (revenues less operating costs) accruing to the firm due to the capital investment. Operating income is subject to tax at all three levels. The effective statutory federal income tax rate, $U_f = u_f (1 - \sigma)$, reflects the reduction in the statutory rate due to the resource allowance at rate σ. Some of the provincial income tax systems also utilize the federal resource allowance, in which case $U_p = u_p (1- \sigma)$.[10] If we assume that the processing allowance ceiling is binding then the effective statutory mining tax rate (U_m) is usually equal to the actual statutory rate times one minus the processing allowance constraint $[u_m(1 - \psi)]$.[11]

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9 Like the federal system, the method of determining depreciation deductions for mining tax purposes may differ from the declining balance approach. The appropriate adjustments are easily made. See footnote 8.

10 Alberta, Saskatchewan, British Columbia and Ontario do not have a resource allowance. The first three provinces allow the deduction of mining taxes and royalties instead, while Ontario does not.

11 Some mining tax regimes, such as Newfoundland, have provisions that are essentially the same as the federal resource allowance. In these cases, the effective statutory mining tax rate is adjusted accordingly.

To this point we have focused almost exclusively upon the decision to invest in physical capital. A similar set of expressions may also be developed for current expenditures on exploration and development. For expenditures on exploration and development an expression analagous to the user-cost equation presented above for physical capital may be written as:

$$MRP = \frac{w(1 - B_1 - B_2 - B_3)}{(1 - U)} \tag{10}$$

with B_1, B_2 and B_3 representing the present value of deductions for federal and provincial income taxes and provincial mining taxes respectively.

Recall from chapter 2 that exploration expenditures (CEE) are fully written off as incurred for federal income tax purposes and are also eligible for an earned depletion allowance of 33 1/3 percent. This means that 133 1/3 percent the cost of exploration is allowed as a deduction. The value of the federal income tax deductions in equation (10) is thus:

$$B_1 = u_f(1 + d) \tag{11}$$

Note that the federal tax rate is not reduced by the resource allowance rate (σ) in equation (11). This is because CEE does not reduce the resource allowance base. As discussed in chapter 2, this means that exploration expenditures are deducted at a higher rate than the associated marginal revenue stream is taxed.

Exploration expenditures are also fully deductible as incurred for provincial income tax purposes, and in most jurisdictions earn depletion. We thus obtain a similar expression for the present value of provincial income tax deductions for exploration:

$$B_2 = u_p(1 + d) \tag{12}$$

Similarly, exploration expenses are typically fully deductible as incurred for provincial mining tax purposes (usually with no depletion allowance), and there is usually no depletion deduction (although this is not the case in every province, as discussed in chapter 2):

$$B_3 = u_m \tag{13}$$

The denominator in equation (10) is identical to (6) as marginal revenues generated by exploration and development are taxed in exactly the same manner as revenues generated from investment in physical capital.

Income and mining taxes can also influence the optimal marginal condition for the holding of inventories. As discussed in chapter 2, inventories are valued

for tax purposes on the basis of the FIFO accounting convention. This means that when used, inventories are valued for tax purposes at the cost of the oldest unit of inventory in stock. When prices are rising, this is less than the current, or replacement cost, of inventories. The use of FIFO accounting for tax purposes thus gives rise to inflationary profits which are subject to tax. As also discussed in chapter 2, to (partially) offset this taxation of inflationary profits, prior to 1986 the federal and provincial governments granted an inventory allowance for income tax purposes equal to 3 percent of the opening balance in inventory. If we assume that inventories are held for a relatively short period of time (i.e., less than one year), then the tax-adjusted user cost of inventories may be expressed as follows:

$$MRP = \frac{R - \pi + (u_f + u_p + u_m)\,\pi - (u_f - u_p)v}{(1 - U)} \qquad (14)$$

where R is defined as in equation (6).

The term $(u_f + u_p + u_m)\,\pi$ represents the increase in the user cost due to the taxation of inflationary inventory profits (as discussed in chapter 2). The term $(u_f + u_p)v$ is the decline in the cost of holding inventories due to the 3 percent inventory allowance available (prior to 1986) for federal and provincial income tax purposes.

Finally, the tax system also can influence the decision of firms to extract depletable resources. In this case the effect is determined solely through the impact of the tax system on the cost of finance.[12] The reduction in the cost of funds due to the deductibility of debt interest for income tax purposes lowers the cost of finance, and thus reduces the opportunity cost of holding the resource in the ground. The tax-adjusted Hotelling Rule is thus:

$$\frac{\dot{P} - \dot{C}'}{P - C'} = R - \pi \qquad (15)$$

3. Effective Tax Rates

As discussed above, the effective tax rate is calculated by taking the difference between the gross-of-tax and net-of-tax marginal rates of return, and dividing by the net-of-tax rate of return. Since the gross rate of return on marginal expenditures is not directly observable we follow neo-classical investment theory and use the tax-adjusted user cost expressions developed above (net of depreciation in the case of physical assets) as a proxy for the gross rate of return.

12 Some provincial mining tax regimes, such as Saskatchewan uranium and potash taxes, levy gross royalties on production. These types of royalties can influence the Hotelling Rule in way not illustrated above.

Using this approach, the gross rate of return (r_g) for depreciable capital is then:

$$r_g = MRP - \delta \tag{16}$$

where MRP is equal to the user cost of depreciable capital given by equation (6).

Inventory goods are assumed not to undergo depreciation, the gross rate of return is thus:

$$r_g = MRP \tag{17}$$

with MRP given by equation (14).

For the depletion decision we may define an analogous measure of the tax distortion. Here the gross rate of return on holding the resource in the ground is equal to the following:

$$r_g = \frac{\dot{P} - \dot{C}'}{P - C'} \tag{18}$$

where the right-hand side of the equation is equal to the after-tax opportunity cost of funds as per equation (15).

For exploration and development, which we assume to be current in nature, the term analogous to the gross rate of return is the after-tax cost of a unit of exploration as expressed in equation (10), or:

$$\frac{w(1 - B_1 - B_2 - B_3)}{(1 - U)} \tag{19}$$

As discussed in the introduction to chapter 3, we are primarily interested in determining the distortion caused by corporate income and mining taxes. The net-of-tax return we are interested in is thus the rate of return net of corporate and mining taxes required on international capital markets. For investment in depreciable capital, inventories and the depletion decision the appropriate net-of-tax real rate of return is given by the international financial market as:

$$r = \beta i + (1 - \beta)\rho - \pi \tag{20}$$

The interest rate on debt (i) and the required return on equity (ρ) are the observed market rates before personal taxes.

For current expenditures on exploration and development the analogous concept is merely the market cost of a unit of exploration and development, or

w, which we normalize to unity in the empirical calculations presented in chapter 3.

For all of the investment and expenditure decisions discussed above except exploration and development, the effective tax rate is then defined as:

$$t_c = \frac{r_g - r}{r} \tag{21}$$

While for exploration and development we merely take the difference between w (normalized to one) and the after-tax cost of exploration and development expressed in equation (19).

For example, for depreciable capital the effective tax rate will be:

$$t_c = \frac{(R - \pi + \delta)(1 - A)}{(1 - U)} - \delta - (r - \pi) \tag{22}$$

where $A = A_1 + A_2 + A_3$, is the after-tax purchase price of a dollar of depreciable capital.

4. Risk and Uncertainty

The user cost expressions discussed above were all developed under the assumption that there is no risk or uncertainty and that firms are fully taxpaying. In this section, the first assumption is relaxed as we introduce risk into the analysis. We continue to maintain the assumption of full taxability or perfect loss offset. This assumption is modified in the next section.

As is discussed in chapter 3, in order to incorporate uncertainty into the analysis it is necessary to define the concept of risk carefully. It has become common to distinguish between at least two types of uncertainty which a firm may face (in this regard, see Bulow and Summers (1984)). The first is known as "income risk". This involves uncertainty regarding future income or revenues. The second type of uncertainty is known as "capital risk". It involves uncertainty regarding the economic rate of depreciation of capital.

In the absence of taxes, both types of risk can be introduced into the user cost expressions quite easily. All that is required is the inclusion of a risk premium which represents the excess return the firm must earn in order to compensate its owners for bearing risk. Thus for depreciable capital we have:

$$E\{MRP\} = r - \pi + \delta + h \tag{23}$$

and for exploration and development:

$$E\{MRP\} = w + h \tag{24}$$

where E is the expection operator conditional on information available at the time the decisions are made, and h is a risk premium.

The above expressions illustrate the fact that risk-averse owners must be compensated for incurring risks. This compensation takes the form of an expected return higher than the risk-free rate. The risk premium h can thus be thought of as representing the opportunity cost of bearing risk. To the extent that a tax system impinges upon this excess return, it may influence the firm's decision to undertake risky expenditures. In order to determine the impact of taxes on risk-taking, it is necessary to specify what form the uncertainty takes; i.e., is it due to income risk or capital risk?

Consider income risk first. In this case the firm faces uncertainty regarding its marginal revenue stream, thus the marginal revenue product is "risky". Everything else is known with certainty. As was discussed in chapter 3, and is shown in more formal fashion in section II of this appendix, under full loss offsetting the tax system allows for the full and immediate deduction of the opportunity cost of risk, and therefore does not impinge upon the risk premium.

Under full loss offset with income risk, the tax-adjusted user cost expression for depreciable assets is thus:

$$(1 - U)\, E\, \{MRP\} = (R - \pi + \delta)(1 - A) + h_i (1 - U)$$

or

$$E\{MRP\} = \frac{(R - \lambda + \delta)(1 - A)}{1 - U)} + h_i \qquad (25)$$

The analogous expression for exploration and development is:

$$E\{MRP\} = \frac{w(1 - B)}{(1 - U)} + h_i \qquad (26)$$

where $A = A_1 + A_2 + A_3$, $B = B_1 + B_2 + B_3$, and h_i is the *income* risk premium.

We measure both the gross and net rates of return on marginal expenditures net of the risk premium (and depreciation in the case of capital assets). This is because, in the presence of risk, all expenditures must earn the market determined *risk-adjusted* rate of return. It is then evident from equations (25) and (26) that the effective tax rate for an income-risky expenditure is similar to the effective tax rate on a riskless expenditure with the same expected return, shown in equation (22). The only difference is that for the risky expenditure the rates of return are expressed in terms of *expected* values. This is because the cost of

bearing income risk is fully deductible under full loss offset taxation and h_i cancels fully in the expression.[13]

Such is not the case for capital risk. Recall that with capital risk the future replacement price of capital and/or the physical rate of depreciation is unknown. With capital risk, even if the tax system allows full loss offset, the appropriate opportunity cost of bearing the risk is not deductible, and taxes can have an additional influence upon the incentive to undertake capital-risky expenditures (*vis-à-vis* riskless expenditures). This is because depreciation allowances for tax purposes are determined on an *ex ante* basis, based upon the original purchase price of the asset, not on its actual replacement cost. This means that if economic depreciation were higher (lower) than anticipated, the tax system would not allow a higher (lower) depreciation claim. This means that tax depreciation allowances granted on an *ex ante* basis do not allow for the appropriate deduction of capital risk.

Nevertheless, the tax system does influence the size of the capital risk premium as follows. Say q_k is the original purchase price of a unit of capital. The capital risk premium is then $h_k (1 - A)q_k$, where A is the total present value of all tax credits and deductions, as above, and h_k is the capital risk premium. As shown in section II of this appendix, if we assume that capital risk takes the form of uncertainty regarding the physical rate of depreciation on the asset, the user cost of capital under capital risk and full loss offset is then:

$$E\{MRP\} = \frac{(R - \pi + \bar{\delta})(1 - A)}{(1 - U)} + \frac{h_k (1 - A)}{(1 - U)} \qquad (27)$$

where $\bar{\delta}$ is the expected rate of depreciation.

Recalling once again that to compute the effective tax rate the gross and net rates of return are defined net of depreciation and risk, it is evident that the tax system does not grant an appropriate deduction for the opportunity cost of bearing capital risk. Thus, taxes impinge upon the risk premium and alter the effective tax rate on risky expenditures *vis-à-vis* riskless investments. To see this, note that the effective tax rate under capital risk will be:

$$\frac{(R - \pi + \delta)(1 - A)}{(1 - U)} - \delta - (r - \pi) + \frac{h_k (U - A)}{(1 - U)}$$

13 We are implicitly assuming that there are no general equilibrium effects on the risk premium due to taxation. This means that the h_i terms in equations (25) and (26) are the same as the h_i terms in equations (23) and (24). This will be the case if the government is no better at pooling risk than are individuals and tax revenues are returned to individuals in a lump-sum stochastic manner. See Gordon (1985) for further discussion on this point.

Unlike the case of income-risky and riskless investments as in equation (22), the effective tax rate under capital risk includes an additional term h_k (U - A)/(1 - U). Interestingly, the improper deduction of capital risk may either increase or decrease the effective tax rate on capital-risky investments, depending upon whether U (the total tax rate on marginal revenues) is greater or less than A (the present value of tax deductions and credits). Thus, full loss offset taxation may either encourage or discourage capital-risky investment *vis-à-vis* riskless (or income-risky) investment. This is a point that does not appear to have been recognized in the previous literature on capital risk (see, for example, Bulow and Summers [1985]).

5. The Impact of Taxes: the Currently Non-Paying Firm

Not all firms are fully taxable at the time an investment decision is made; nor, as discussed in chapter 2, does the current tax system grant full loss offsets. A firm may be non-taxable, for example, due to large banks of past tax losses. In this case, the income (write-offs) generated by the marginal investment may not be taxed (deducted) until some later point in time. Alternatively, a new firm may be making its initial investment, which earns income only at some later point in time. In this case, credits and deductions cannot be written off against income generated from past investments and must be postponed.

When firms may not be taxable over the life of the project, it is necessary to adjust the user cost of capital expressions developed above. To do this in an analytically (and empirically) tractable fashion, it is necessary to make some very specific assumptions about the time profile of tax loss claims.

As discussed in chapter 3, we distinguish between three types of tax loss situations. The first is the fully taxpaying or full loss offset case discussed above. The second is what we call the "currently non-taxpaying case". In this case the firm does not pay taxes on the marginal expenditure at the time of the investment because of the build-up of past losses and unused deductions. However, the firm will become taxable in the future, and knows with *certainty* the time profile of its future tax payments and deductions. The third situation is what we call the "start-up firm case". Here, the firm is making an initial investment. It does not know whether or when it will be taxable in the future. This introduces another element of uncertainty. We deal with each of these tax loss cases in turn.

It should be stressed that these cases by no means exhaust all of the possibilities. Indeed, each tax loss case is unique, depending upon the time profile of the firm's expected cash flow. We present these cases primarily for illustrative purposes, in order to show how imperfect loss offsetting can influence the impact of taxation upon the investment decision.

The Currently Non-Taxpaying Case

To deal with the currently non-taxpaying case, we define the concept of a tax loss "refundability" parameter. This parameter can be thought of as representing the degree of loss offsetting in the system. It is determined by discounting the estimated proportion of tax losses and unused deductions used by companies due to the carry-over provisions and the rules which allow deductions to be carried forward in tax pools. (See chapter 2 for a description of these provisions.) Two measures of refundability are defined. The first is a "marginal" refundability parameter. It is calculated under the assumption that the loss generated by the marginal project is claimed at the end of a specified period. For example, say all tax losses and unused deductions are claimed by period T. Let ξu be the present value of taxes paid on one dollar of income. With marginal refundability, the tax loss generated by a marginal investment is not claimed until period T; therefore, the refundability parameter is:

$$\xi = 1 / (1 + R)^{T}. \tag{28}$$

The second measure is an "average" refundability parameter. This parameter is calculated by assuming that tax losses generated by the marginal investment are deducted in a straightline fashion over the specified period T. Moreover, a portion of the loss may be carried back for deduction against past taxes and an immediate refund. If λ of the loss is carried back and $(1 - \lambda) / T$ of the loss is written off in each year until period T, then the average refundability parameter is determined by:[14]

$$\xi = \lambda + \frac{(1 - \lambda)(1 + R)^{-T}}{TR} \tag{29}$$

Note that we implicitly assume that the firm cannot influence the value of ξ; it is assumed to be given exogenously. While clearly unrealistic, only in this manner are we able to derive a result that lends itself to analytical and empirical evaluation.

The formulae for the user cost of capital when firms are currently non-taxable under the corporate income tax are obtained by simply multipying u_f and u_p in the formulae derived above for the fully taxpaying case by ξ. In the empirical illustrations which appear later in the paper, to simplify the calculations we assume that firms are always taxable under the provincial mining tax and therefore do not reduce u_m by a refundability parameter. Thus, in the currently non-taxpaying case the impact of imperfect loss offsetting is merely to reduce the (effective) statutory income tax rates.

14 We assume that all investment tax credits are fully claimed as earned.

The Start-up Firm Case

The start-up firm case is somewhat more complicated. Here, a "start-up" firm commits itself to an investment project not knowing what its future tax status will be. Unlike the currently non-taxpaying case where the firm is assumed to know the time profile of future tax payments and deductions, here the tax rate itself is stochastic. In the case of income risk, it is shown in section II of this appendix that the tax-adjusted user cost in the case of a start-up firm under imperfect loss offset is:

$$E\{MRP\} = \frac{(R - \pi + \delta)(1 - A)}{(1 - U)} + h_i + \frac{U(1 - \xi)\mu}{(1 - U)} \qquad (30)$$

where μ is an extra premium associated with the lack of full loss offset taxation, and all other parameters are as defined as above. It is difficult to provide an intuitive explanation for the last term in equation (30). It is perhaps easiest to think of it as the additional cost a start-up firm faces due to uncertainty regarding the use of its tax deductions. It can thus be thought of as the expected corporate tax loss per dollar of capital expenditure. A specific expression for μ is derived in section II of this appendix; however, note that if loss offsetting is full, then ξ is one, and (30) reduces to equation (25). Analogous expressions can be derived for exploration and development, and inventories.

Note from equation (34) that the tax system impinges upon the premium μ. This means that the effective tax rate on start-up firms under imperfect loss offset is greater than start-up firms under full loss offset. We thus see the importance of full loss offset in allowing the full deductibility of the opportunity cost of risk in the income-risk case.

6. Flow-Through Shares

As discussed in chapter 3, there are three different ways in which the use of flow-through-share financing has tax implications for the exploration and development decision of mining firms. First, the tax deductions are renounced to shareholders, which means that the tax saving takes place at the personal tax rate rather than the corporate tax rate. Second, the adjusted cost base for flow-through shares is set equal to zero for capital gains tax purposes. Third, flow-through shares involve the issue of new equity; as long as the capital gains tax rate is less than the personal tax rate on dividends, there is a tax disadvantage to using new share issues for financing, rather than, say, debt or retained earnings.

Given this general backdrop, we now derive an expression for the cost of capital under flow-through-share financing. We begin with the well known result that in the absence of taxation and given the firm's operating/investment decisions, an issue of new shares results in a dollar-for-dollar loss in the value

of existing shares. Thus, if a new share issue is used to finance a new investment opportunity, the investment must give rise to a stream of dividends which at least compensates the existing shareholders for their capital loss. If the project is capital in nature, it should generate a dividend stream into the future. If it is a current expenditure, the resulting dividend will be once and for all.

Financing by Ordinary New Share Issues

Consider a $1 issue of ordinary new shares used to finance a current expenditure on exploration in the presence of a tax system. We know that existing shares will decline in value by $1. This means that the wealth of the existing shareholders will decline by $(1 - c) after the imposition of a capital gains tax, where c is the capital gains tax rate on an accruals basis. In order to compensate existing shareholders, dividends must rise at least by $(1 - c). However, dividends are taxed on receipt, therefore it is after-tax dividends $(1 - \theta)\Delta D$ which must rise by (1 - c) (where θ is the tax rate on dividends, and ΔD is the change in dividends). This means that in order for the new issue to be acceptable to the existing shareholders, current before-tax dividends must increase by:

$$\Delta D = \frac{(1 - c)}{(1 - \theta)} \qquad (31)$$

Since c is usually less than θ, it is evident from equation (31) that the tax system discriminates against new share issues since the required change in dividends is greater than the $1 raised in capital. This is the result discussed above, that there is a tax disadvantage to using new share issues for financing due to the preferential treatment of capital gains relative to dividends.

If we assume that exploration expenditures are current in nature and thus give rise to revenue immediately, the impact of a $1 new share issue to finance exploration on current dividends is, at the margin:

$$\Delta D = MRP\ (1 - u) + U\ (1 + d) \qquad (32)$$

where $u = (u_f + u_p)\ (1 - \sigma)$, $U = u_f + u_p$, σ is the resource allowance and d is the earned depletion rate. Equation (32) simply states that for a fully taxpaying firm, using the $1 raised by the new share issue to finance exploration will increase current dividends by the sum of the net of tax marginal revenue product, MRP(1 - u), and the tax savings arising from the CEE and earned depletion deduction U(1 + d). For expositional simplicity, we ignore provincial mining taxes in the above expression. From equation (31) we know that, to compensate existing shareholders, the change in dividends must be $\Delta D = (1 - c)/(1 - \theta)$. Combining (31) and (32) we may compute the before-tax rate of return required on a marginal investment in exploration financed by a new share issue as follows:

$$MRP = \frac{(1-c)}{(1-\theta)(1-u)} - \frac{U(1+d)}{(1-u)} \qquad (33)$$

Financing by Flow-Through Shares

Due to their special tax status, the selling price of flow-through shares will differ from that of ordinary shares. As discussed above, aside from the tax disadvantage associated with all new share issues, the important tax factors affecting the price of a flow-through share are two-fold: i) the flow-through of tax benefits deducted by the investor, and ii) the additional capital gains tax on disposition due to the zero cost base for flow-through shares. The former implies a higher price than ordinary shares while the latter implies a lower price. The actual price of a flow-through share will be determined by both of these effects.

Let x be the price of a flow-through share and e the price of an ordinary share. If the tax effects are fully capitalized by the market in the price for the flow-through share, x must satisfy:

$$x = e + xm(1+d) - ec \qquad (34)$$

where m is the personal tax rate. The first term in the expression is just the price of an ordinary (non-flow-through) share. The second term reflects the premium on the share due to the flow-through of the CEE and depletion deductions evaluated at the personal tax rate (m), while the last term reflects the negative impact on the price of the zero-cost-base requirement for capital gains tax purposes. The net flow-through share premium is then $xm(1 + d) - ec$. If we normalize the price of an ordinary share to unity and solve for x, the price of a flow-through share will be:

$$x = \frac{1-c}{1-m(1+d)} \qquad (35)$$

Note that if $m(1 + d) > c$, then $x > 1$, and the price of the flow-through share is greater than the price of an ordinary share. We would think that this would typically be the case.

If a flow-through share is sold for x, then the resulting change in dividends from a marginal investment in exploration is $\Delta D = MRP(1 - u)x$. Note that this differs from equation (32) in that it excludes the value of the tax deductions for CEE and earned depletion at the firm level. This obviously results because these tax deductions have been flowed through to investors. Moreover, we assume that the firm becomes taxable immediately due to the flow-through of the tax deductions; thus MRP is taxed at the full corporate tax rate. More realistically, the firm will only become taxable at a later point in time. This is easily

incorporated by reducing u by the loss offset parameter ζ discussed above with regard to the non-taxpaying firm.

Using the value of x determined in equation (35), the change in dividends due to the investment of the proceeds from the flow-through share issue in exploration is:

$$\Delta D = \frac{MRP\,(1-u)\,(1-c)}{1-m\,(1+d)} \qquad (36)$$

Recall from equation (31) that, to compensate existing shareholders, the marginal investment in exploration financed by a new share issue must change dividends by $\Delta D = (1 - c) / (1 - \theta)$. We may substitute this into equation (36) to determine the before-tax return required on a marginal investment in exploration financed by flow-through shares, as follows:

$$MRP = \frac{1-m\,(1+d)}{(1-\theta)\,(1-u)} \qquad (37)$$

The equations presented in section I above for exploration and development, particularly equation (10), implicitly assumed that exploration and development are financed by retained earnings. In order to compare this type of financing with ordinary share issues and flow-through shares, equation (10) is reproduced below ignoring provincial mining taxes and differential provincial income tax treatment. The required before-tax return on a marginal investment in exploration financed by retained earnings is thus:

$$MRP = \frac{1-U\,(1+d)}{(1-u)} \qquad (38)$$

This equation also corresponds to the situation where the government grants full loss offsets.

Under the original tax reform proposals, the earned depletion allowance was eliminated for all expenditures, regardless of how they were financed. This means that d would be set to zero in equations (33), (37) and (38) for the reform regime. However, as discussed in chapter 2, the legislation ultimately passed granted a 30 percent grant for exploration financed by flow-through shares (up to a maximum of $10 million). Thus, for the post-reform regime, the price of a flow-through share would be $x = e + x(1 - g)\,m + g - ec$, where g is the grant rate (recalling that the CEE tax deduction is reduced by the grant), or, normalizing the price of an ordinary share to $1, $x = (1 - c + g)/(1 - m(1 - g))$. Following the same steps as above, the before-tax rate of return required on a marginal expenditure on exploration would be:

$$MRP = \frac{(1-c)[1-m(1-g)]}{(1-\theta)(1-u)(1-c+g)} \qquad (39)$$

Using the above equations, we may compare the impact of the tax system on the incentive to finance exploration by ordinary new share issues, flow-through shares or retained earnings. In fact, the relative attractiveness of the three financing options depends upon the values of the tax parameters in the equations. A full evaluation of the impact of flow-through-share financing thus requires empirical investigation, which we undertake in chapter 3 of the text. In appendix B we discuss the parameter values we assume to perform this empirical analysis (important here are the capital gains tax rate, c, and the personal tax rate on dividends, θ).

II. Formal Derivation of the User Cost Formulae

In this section we extend the analysis conducted in section I to derive the expressions in a more formal fashion. The expressions are derived for relatively simple, stylized tax systems. User cost formulas for more specific types of capital under each of the tax regimes discussed in chapter 2 are presented in section III at the end of the appendix.

1. Methodology

To derive the user cost expressions discussed in section I we make the following assumptions:

1. The debt/asset ratio is fixed and all (marginal) investments are financed using the pre-determined mix of debt and equity.

2. Firms maximize the present value of shareholder wealth, which is equivalent to maximizing the present value of non-financial cash flows discounted at the after-tax discount rate R (see Boadway [1986]).

A) The Riskless Case (Full Loss Offset)

The firms's problem is to maximize the present value of its "non-financial" cash flow discounted at the after-tax weighted average cost of finance:

$$R = i\beta(1 - u_f - u_p) + (1 - \beta)\rho$$

Suppressing time subscripts for notational ease, the firm's cash flow is:

$$CF = PQ\,C(Q) - I - X - T_c - T_m$$

where P is the price of a unit of output, Q is output, C(Q) is the extraction cost function, I is gross investment in physical capital, X is expenditures on explora-

tion and development, T_c corporate income taxes and T_m corporate mining taxes.

Income taxes are determined as follows:

$$T_c = (u_f + u_p)(PQ - \alpha_f B - wX - RA - DA)$$

where B is the undepreciated capital cost of capital for CCA purposes, RA is the resource allowance, and DA the depletion allowance. The rest of the variables follow the notation introduced in section I.

The resource allowance is:

$$RA = \sigma[PQ - C(Q) - \alpha_f B]$$

while the depletion allowance is determined by:

$$DA = dX$$

Note that the depletion allowance claim is assumed to not be constrained by the 25 percent profit ceiling. The allowance could alternatively be modelled by assuming the constraint in binding.

Mining taxes are:

$$T_m = u_m \ [PQ - C(Q) - wX - \alpha_m B_m]$$

where B_m is the undepreciated cost of capital for mining tax depreciation purposes.

Incorporating the tax expression in the equation defining the firm's cash flow gives us the following:

$$CF = PQ \ [1 - (u_f + u_p)(1 - \sigma) - u_m] - wX \ [1 - (u_f + u_p)(1 + d) - u_m] - I + \alpha_f B \ (u_f + u_p)(1 - \sigma) + \alpha_m B_m u_m$$

The present value of CF, discounted at R as defined above, is maximized subject to two sets of constraints. The first set describes the movement of the stock variables K, B, and B_m over time, as follows:

$$\dot{K} = I - \delta K$$

$$\dot{B} = qI - \alpha_f B$$

$$\dot{B}_m = qI - \alpha_m B_m$$

where q is the (nominal) cost of a unit of physical capital (which we normalize to unity), and a dot above a variable denotes its time derivative. These three equations are equations of motion for the state variables. For example, the change in the capital stock over time is equal to the amount of (physical) units of capital acquired through investment (I) less the amount lost due to depreciation (δK).

The second set of constraints concerns the search, discovery, and extraction of the depletable resource. We envisage a three-stage process something like the following. In the first stage the firm undertakes exploration and development and discovers a resource S according to the function G(X). In the second stage, this resource is combined with physical capital to produce a stock of depletable reserves according to the function F(S, K). In the final stage the resource is extracted to produce output Q according to the current cost function C(Q). Note that it does not matter at which stage physical capital is introduced. Moreover, the exploration and development processes may be split up to occur at different stages. None of this matters to the result derived below. For a more extensive discussion of this approach, see Boadway, Bruce, McKenzie and Mintz (1987).

This scenario gives rise to two constraints:

$$\int_0^{\infty} [Q - F(S, K)]\, dt \leq 0$$

$$\int_0^{\infty} [S - G(X)]\, dt \leq 0$$

The first of the constraints states that the total amount of the resource extracted cannot exceed the total amount developed for extraction. The second states that the total amount developed for extraction cannot exceed the total amount found. In general, a similar set of constraints must be satisfied at each point in time for cumulative past discoveries and developed resources. For simplicity, we assume that these latter do not bind, but the above do.

The firm's problem has now been completely characterized. The firm chooses K, X, and Q at each point in time so as to:

$$\text{Max} \int_0^{\infty} e^{-Rt} CF\, dt$$

subject to the two sets of constraints defined above.

After some simplification, the first-order conditions for this problem reduce in the steady state (where the capital stock is constant with gross investment equal to replacement investment) to:

$$(P - C')\,\partial F/\partial K = \frac{(R - \pi + \delta)\,(1 - A_1 - A_2 - A_3)}{(1 - U)}$$

$$(P - C')\,(\partial F/\partial S)\,(\partial G/\partial X) = \frac{w(1 - B_1 - B_2 - B_3)}{(1 - U)}$$

$$\frac{\dot{P} - \dot{C}'}{P - C'} = R - \pi$$

where the A's and B's are defined exactly as in section I (see also Boadway, Bruce, McKenzie and Mintz (1987)).

The equations are identical to the formulae presented in section I for physical capital, exploration and development, and the depletion decision under full loss offset and perfect certainty.

A slightly different model is needed to generate the user cost of inventory capital. We do not reproduce the model here but instead refer the reader to Boadway, Bruce and Mintz (1982).

B) Income Risk

The easiest way to develop the expressions incorporating income uncertainty is to consider a simple two-period model. In the first period, the firm must make investment and expenditure decisions. In the second period, income is produced. In the case of income risk this income is stochastic. For simplicity, we develop the user cost expression for physical capital only, and consider only the corporate income tax system. The inclusion of a provincial mining tax system and other types of expenditures is straightforward.

The firm's problem is to choose the level of capital stock, K, which maximizes expected after-tax profits:

$$E\,\{G\,[F\,(K, s)\,(1 - u)\,(R - \pi + \delta)\,K + u\kappa K\,]\}$$

where E is the expectations operator, G [·] is the firm's utility function over profits with $G' > 0$, $G'' \leq 0$ (the firm is risk-averse), R is the nominal after-tax cost of finance, and thus $(R - \pi + \delta)$ is the opportunity cost of a unit of capital, κ is the real flow value of depreciation allowances used for tax purposes, and s is a stochastic technology parameter unknown to the firm in period one when the investment decision is made. We thus model the income risk as originating with technological uncertainty.

The first-order condition for this problem is as follows:

$$E\,\{\,G'\,[F_K\,(1 - u) - (R - \pi + \delta) + u\kappa]\} = 0$$

which we may simplify to:

$$(1 - u)\, E\,\{G'F_k\} = (R - \pi + \delta)EG' - u\kappa EG'$$

or, dividing by (1 - u):

$$E\{G'F_k\} = \frac{(R - \pi + \delta)EG'}{(1 - u)} - \frac{u\kappa EG'}{(1 - u)}$$

or, dividing through by EG′:

$$\frac{E\{G'F_k\}}{EG'} = \frac{(R - \pi + \delta)}{(1 - u)} - \frac{u\kappa}{(1 - u)}$$

recalling that G′ and F_k are stochastic as they are functions of s.

Using covariance decomposition, where E{xy} = ExEy + Cov (x,y) if both x and y are stochastic variables, the above expression may be written as:

$$EF_k = \frac{(R - \pi + \delta)}{(1 - u)} - \frac{u\kappa}{(1 - u)} + h_i$$

where $h_i = \dfrac{-\,\mathrm{Cov}\,(G', F_k)}{EG'}$ is the income risk premium, which is positive if the individual is risk-averse.

This two-period framework is not perfectly analogous to the multiperiod continuous time case considered in the first part of the appendix. In order to derive a formula more in line with our previous expressions, it is necessary to re-express the tax depreciation deduction, uκ, in a more familiar form. Mintz (1987) shows how this may be done. We assume that the after-tax discount rate is constant over time, and that the firm replaces depreciated capital every period in order to maintain a constant capital stock. To maintain a constant value of the capital stock depreciating at δ, additional nominal depreciation allowances awarded in the future are:

$$\int_0^\infty \delta e^{-(R-\pi)t} K dt = K\delta/(R - \pi)$$

Moreover, we know from section I that the present value of tax depreciation allowances on a unit of capital is:

$$K = \int_0^\infty \alpha e^{-(R+\alpha)t}\alpha = \alpha/(R + \alpha)$$

For a constant flow value of depreciation allowances, κ, we solve the following equation for κ, using the above:

$$\int_0^\infty \kappa e^{-(R-\pi)t}dt = K + \int_0^\infty \delta e^{-(R-\pi)}Kdt$$

The solution is $\kappa = (R - \pi + \delta)\ \alpha/(R + \alpha) = (R - \pi + \delta)Z$, where $Z = \alpha/(R + \alpha)$. Substituting this in the first-order condition obtained above for physical capital, and rearranging gives us:

$$E\{Fk\} = \frac{(R-\pi+\delta)(1-A)}{(1-u)} + h_i$$

where $A = uZ$, is the present value of CCA deductions.

This is similiar to the user cost expression presented in section I for depreciable capital under income risk. The only difference is that we ignore provincial mining taxes. It should be obvious how these can be included.

C) Capital Risk

Capital risk can be modelled in a similiar manner. Recall from chapter 3 that capital risk may arise either from uncertainty regarding the future rate of wear and tear on physical capital or from uncertainty about future capital good prices. In the derivation that follows, we assume that the source of capital risk is the former. Thus the economic rate of depreciation, δ, is stochastic. As above, for ease of exposition provincial mining taxes are ignored. The firm chooses K to maximize:

$$E\ \{G\ [F(K)\ (1 - u) - (R - \pi + \delta(s))K + \kappa(s)uK\ ]\}$$

where $\kappa(s)$ is also stochastic and is equal to $[R - \pi + \delta(s)]\ Z$. The first-order condition is:

$$E\ \{G'\ [F_k\ (1 - u) - (R - \pi) - \delta(s) + \kappa(s)u\ ]\ \} = 0$$

This may be re-arranged to give:

$$F_k\ (1 - u)EG' = (R - \pi)EG' - EG'\delta(s) - uEG'\kappa(s)$$

Substituting the definition of $\kappa(s)$ into the above equation and rearranging gives:

$$F_k = \frac{(R-\pi+\hat{\delta})}{(1-u)} - \frac{EG'\delta(s)}{EG'(1-u)} - \frac{uEG'[(R-\pi+\delta(s)]Z}{EG'(1-u)}$$

where $\hat{\delta}$ is the expected value of δ (i.e., $E\{\delta(s)\} = \hat{\delta}$).

Using covariance decomposition, remembering that G' and $\delta(s)$ are both stochastic, gives us:

$$F_k = \frac{R - \pi + \hat{\delta} - uZ\,\hat{\delta} - u(R - \pi)Z + h_k - h_k\,uZ}{(1 - u)}$$

$$= \frac{(R - \pi + \hat{\delta} + h_k)(1 - uZ)}{(1 - u)}$$

where h_k is the capital risk premium equal to Cov $[G', \delta(s)] / EG'$.

D) Imperfect Loss Offset

The method by which we adjust the user cost expressions for imperfect loss offsetting in the currently non-taxpaying case is described in section I. Here, we show how the above condition under income risk may be adjusted to give the cost of capital expression for the start-up firm case. Once again, we focus on physical capital and ignore provincial mining taxes for simplicity.

Recall that the start-up firm does not know its future tax status. To incorporate this idea in an analytically tractable fashion, we assume that there exist "states of nature", $s \in [0, \bar{s}]$, with a probability density function, $g(s)$ which is known to the firm, where:

$$\int_0^{\bar{s}} g(s)\,ds = 1$$

One way to think of the problem is that the corporate tax rate, u, is stochastic. Using this approach, let $u(s)$ be the state-contingent corporate tax rate, and $CT(s)$ the corporate tax base in state s. If $CT(s) \geq 0$, then $u(s) = u$, and if $CT(s) < 0$, then $u(s) = \xi u$, where ξ is the refundability parameter described in chapter 3. The state of nature s_c is then defined such that $CT(s_c) = 0$; i.e., s_c is the state of nature in which the firm becomes taxable. The states are ordered such that if $s > s_c$ then $CT(s) > 0$.

The firm then solves a problem similiar to that stated above for income risk, except that now the corporate tax rate is assumed to be stochastic, dependent upon the state of nature, s:

$$\text{Max } E\{G[F(K, s)(1 - u(s)) - (R(s) - \pi + \delta)K + \kappa u(s)K]\}$$

where $R(s)$ is now stochastic as it is equal to $(i\beta[1 - u(s)] + (1 - \beta)\rho$. The first-order condition is:

$$E\{G'(F_k\,[1 - u(s)] - (R(s) - p + \delta) + u(s)\kappa)\} = 0$$

Substituting the definition of R(s) into the first-order condition and rearranging gives us:

$$EG'\{F_k - (i\beta + (1-\beta)\rho - \pi + \delta)\} - EG'\{F_k u(s) - i\beta u(s) - \kappa u(s)\} = 0$$

Adding and subtracting $F_k u$, $i\beta u$, and κu inside the second set of curly brackets, where u is the actual statutory corporate tax rate (which is not stochastic), and rearranging yields:

$$EG'\{F_k - [i\beta + (1-\beta)\rho - \pi + \delta] - F_k u + i\beta u + \kappa u\}$$

$$= -EG'\{[F_k - i\beta - \kappa][u - u(s)]\}$$

which, dividing by EG′ and rearranging, may be written as:

$$\frac{EF' F_k (1-u)}{EG'} = (R - \pi + \delta) - \kappa u - \frac{EG'\{[F_k - i\beta - \kappa][u - u(s)]\}}{EG'}$$

where R is now defined as usual, with $R = i\beta(1-u) + (1-\beta)\rho$ (and is non-stochastic). Note that $F_k - i\beta - \kappa$ is the derivative of the corporate tax base with respect to K. Thus define it as CT′. It is now necessary to evaluate the last term in the above expression. Ignoring for a moment the denominator, we use the density function for s to write:

$$EG'CT'[u - u(s)] = u\int_0^{\bar{s}} G'CT'g(s)ds - \int_0^{\bar{s}} G'CT'u(s)ds$$

$$= u\int_0^{s_c} G'CT'g(s)ds + u\int_{s_c}^{\bar{s}} G'CT'g(s)ds$$

$$- \int_0^{s_c} G'CT'u(s)g(s)ds - \int_{s_c}^{\bar{s}} G'CT'u(s)g(s)ds$$

Now, recalling that $u(s) = u$ when $s_c \le s \le \bar{s}$, and $u(s) = \xi u$ when $0 \le s < s_c$, we may rewrite this as follows:

$$EG'CT'[u - u(s)] = u\int_0^{s_c} G'CT'g(s)ds + u\int_{s_c}^{\bar{s}} G'CT'g(s)ds$$

$$- \xi u\int_0^{s_c} G'CT'g(s)ds - u\int_{s_c}^{\bar{s}} G'CT'g(s)ds$$

$$= u\,(1-\xi)\int_0^{d_c} G'CT'g(s)ds$$

Substituting this in the first-order condition obtained above gives:

$$\frac{EG'T_k\,(1-u)}{EG'} = (R-\pi+\delta) - \kappa u - u(1-\xi)\int_0^{d_c}\frac{G'CT'g(s)ds}{EG'}$$

or, dividing by (1 - u) and defining $\mu = -\int_0^{d_c}\frac{G'CT'g(s)ds}{EG'}$, gives us:

$$\frac{EG'F_k}{EG'} = \frac{(R-\pi+\delta)-\kappa u}{(1-u)} + \frac{u(1-\xi)\,\mu}{(1-u)}$$

Using covariance decomposition and utilizing the definition of κ as above, this may finally be written as:

$$EF_k = \frac{(R-\pi+\delta)\,(1-A)}{(1-u)} + h_i + \frac{u\,(1-\xi)\,\mu}{(1-u)}$$

which is again similar to the expression presented in Chapter 3.

III. Specific User Cost Formulae

As shown in sections I and II, the general formula for computing the user cost of capital (under full loss offset and no risk) for depreciable capital is:

$$MRP = \frac{[R-\pi+\delta]\,[1-A_1-A_2-A_3]}{(1-U)}$$

The analogous formula for current expenditures is:

$$MRP = \frac{[1-B_1-B_2-B_3]}{(1-U)}$$

with the parameters defined as above.

The user cost expressions derived in sections I and II for inventories and depletable assets apply to all provinces (except Saskatchewan, which is a "special case" discussed at the end of the appendix).

In sections I and II, very general expressions were developed for the user cost of capital. However, in fact, the formulae for U, R, the A's and the B's actually differ across provinces and capital types. In this section, the exact

expressions used to derive effective tax rates for the various provincial regimes and different types of capital are presented. Expressions are presented for all of the regimes discussed in chapter 2 for the following types of expenditures:

- grassroots exploration
- pre-production development
- post-production development
- property rights
- depreciable capital
- inventories
- the depletion decision.

In many cases, it is necessary to make simplifying assumptions in order to express the tax regimes in a manner conducive to analytical and empirical evaluation. Nevertheless, in most cases the formulae should reflect the general character of the regimes discussed in chapter 2. The formulae are presented with little explanation, nevertheless given the above discussion, the intuition behind the expressions should be self-evident in most cases.

Although the mining tax regimes differ significantly across provinces, as the discussion of chapter 2 implies, most of the systems can be modelled within a fairly common framework. An exception, however, is the uranium and potash tax systems in Saskatchewan. Both of these regimes are unique and not directly comparable to the other systems. Hence, a brief description of the way in which these regimes are represented is contained at the end of the appendix.

A. The Marginal Cost of Finance (R)

a) For all provinces except Ontario and British Columbia:

$$R = \beta i (1 - u_f - u_p) + (1 - \beta)\rho$$

b) Ontario:

$$R = \beta i [1 - u_f - u_p (1 - \gamma)] + (1 - \beta)\rho$$

c) British Columbia:

$$R = \beta i (1 - u_f - u_p - u_m) + (1 - \beta)\rho$$

B. The Marginal Tax Rate on the Net Revenue Stream (U)

a) Ontario:

$$U = u_f (1 - \sigma) + u_p (1 - \gamma) + u_m (1 - \psi)$$

b) British Columbia:

$$U = u_f (1 - \sigma) + u_p + u_m (1 - \psi) (1 - u_p)$$

c) Newfoundland:

$$U = (u_f + u_p) (1 - \sigma) + u_m(1 - \psi) (1 - \sigma_m)$$

d) Manitoba, Nova Scotia, Quebec:

$$U = (u_f + u_p) (1 - \sigma) + u_m (1 - \psi)$$

e) New Brunswick:

$$U = (u_f + u_p)(1 - \sigma) + u_{m1}(1 - \psi) + u_{m2} (1 - (1 - \psi)u_{m\,1})(1 - \sigma_m)$$

C. Present Value of Federal Income Tax Credits and Deductions

The following formulae apply to all provinces:

a) Normal Mine assets

$$A_1 = \phi + (1 - \phi) u_f (1 - \sigma)Z$$

b) New mine (class 28) and processing assets

$$A_1 = \phi + (1 - \phi) u_f (1 - \sigma)Z + u_f (1 - \phi)d$$

c) Grassroots exploration and pre-production development

$$B_1 = u_f (1 + d)$$

d) Post-production development

$$B_1 = u_f (1 - \sigma)$$

e) Property rights

$$B_1 = u_f Z_d$$

Z is the present value of CCA deductions. For declining-balance classes with no half-year convention the appropriate formula is:

$$Z = \int_0^{\infty} \alpha e^{-Rt} dt = \alpha/(R + \alpha)$$

For class 28 assets written off immediately, Z = 1.
The half-year rule can be approximated (for empirical purposes) as follows:

$$Z = \alpha/2 + \frac{(1 - \alpha/2)\,\alpha}{(\alpha + R)\,(1 + R)}$$

For straight-line classes the appropriate formula is:

$$Z = \int_0^{T} (1/T) e^{-Rt} dt = \frac{1 - e^{-RT}}{RT}$$

Z_d is the present value of the CDE claims, determined exactly as Z above to be:

$$Z_d = \alpha_d / (R + \alpha_d)$$

D. Present Value of Provincial Income Tax Credits and Deductions

a) Normal mine assets

i) All provinces except Ontario, Alberta, British Columbia and Saskatchewan:

$$A_2 = (1 - \phi)\, u_p\, (1 - \sigma) Z$$

ii) Ontario:

$$A_2 = (1 - \phi)\, u_p\, (1 - \gamma) Z$$

iii) Alberta, British Columbia, Saskatchewan:

$$A_2 = (1 - \phi) u_p Z$$

b) New mine (class 28) and processing assets

i) All provinces except Ontario, Alberta, British Columbia and Saskatchewan

$$A_2 = (1 - \phi) u_p\, (1 - \sigma) Z + u_p d$$

ii) Ontario:

$$A_2 = (1 - \phi)u_p (1 - \gamma)Z + u_p d$$

iii) Alberta, British Columbia, Saskatchewan:

$$A_2 = (1 - \phi)\, u_p Z + u_p d$$

c) Grassroots exploration and pre-production development

i) All provinces except Ontario:

$$B_2 = u_p (1 + d)$$

ii) Ontario:

$$B_2 = u_p (1 - \gamma)$$

d) Post-production development

i) All provinces except Ontario, Alberta, British Columbia and Saskatchewan:

$$B_2 = u_p (1 - \sigma)$$

ii) Ontario, British Columbia, Alberta, Saskatchewan:

$$B_2 = u_p$$

e) Property rights

i) All provinces except Ontario and Quebec:

$$B_2 = u_p Z_d$$

ii) Quebec:

$$B_2 = u_p$$

iii) Ontario:

$$B_2 = u_p (1 - \gamma)$$

E. Present Value of Provincial Mining Tax Credits and Deductions

a) Normal mine assets

i) Ontario:

$$A_3 = u_m(1 - \psi)\, Z_m(1 - \phi)$$

ii) Quebec:

$$A_3 = u_m(1 - \psi)Z_m$$

iii) British Columbia:

$$A_3 = u_m\,(1 - \psi)Z\,(1 - u_p)$$

iv) Newfoundland:

$$A_3 = u_m(1 - \psi)Z_m(1 - \sigma_m)$$

v) New Brunswick:

$$A_3 = u_{m2}\,(1 - \psi)Z_m + \frac{u_{m2} \cdot x}{R + \alpha_m}$$

vi) Manitoba and Nova Scotia:

$$A_3 = u_m(1 - \psi)Z_m$$

b) New mine (class 28) assets

For new mine assets A_3 is the same as normal mine assets in most provinces. In Ontario, New Brunswick, Manitoba and to some extent in Nova Scotia, new mine assets may be written off up to income from the mine. In these cases Z_m is set to 1 above.

c) Processing assets

i) In all provinces except Manitoba and Quebec, A_3 is the same as normal mine assets if the processing allowance constraint is binding (which we assume to be the case). In Ontario processing assets are written off at a lower rate than normal mine assets.

ii) Quebec:

$$A_3 = u_m (1 - \psi)Z_m + u_m (1 - \psi)(1 + d_p)$$

iii) Manitoba:

$$A_3 = u_m (1 - \psi)$$

The manner and rates at which depreciation allowances are claimed for mining tax purposes vary among the provinces. In some provinces the allowances are claimed on a straight-line basis while in others a declining-balance system is used. In either case the appropriate formulae are similar to those described for the present value of federal CCA deductions (Z) above. See chapter 2 and/or appendix B for a description of the depreciation systems for the various regimes.

d) Grassroots exploration

i) Ontario, Nova Scotia, Manitoba, Newfoundland:

$$B_3 = u_m(1 - \psi)$$

ii) Quebec and New Brunswick:

$$B_3 = u_m(1 - \psi) (1 + d_p)$$

iii) British Columbia:

$$B_3 = u_m(1 - \psi)(1 - u_p)(1 + d_p)$$

e) Pre-production development

i) Ontario, Nova Scotia, New Brunswick, Newfoundland:

$$B_3 = u_m(1 - \psi)$$

ii) Quebec:

$$B_3 = u_m(1 - \psi)(1 + d_p)$$

iii) Manitoba:

$$B_3 = u_m(1 - \psi)Z_m$$

iv) British Columbia:

$$B_3 = u_m(1 - \psi)(1 - u_p)(1 + d_p)$$

f) Post-production development

i) Ontario, New Brunswick, British Columbia:

$$B_3 = u_m(1 - \psi)$$

ii) Quebec:

$$B_3 = u_m (1 - \psi)(1 + d_p)$$

iii) Newfoundland:

$$B_3 = u_m(1 - \psi)Z_m(1 - \sigma_m)$$

iv) Manitoba and Nova Scotia:

$$B_3 = u_m(1 - \psi)Z_m$$

e) Property rights

Property rights are not deductible for mining tax purposes in any of the provinces.

F. Inventories and Depletable Assets

The expressions developed for U and R for each of the provinces may be substituted into the user cost expressions developed for inventories and the depletion decision in chapter 3.

G. Saskatchewan's Uranium and Potash Taxes

The unique feature of the Saskatchewan mining tax system as it relates to potash and uranium is the form of its graduated rate schedule. The schedule is progressive, but not in relation to income, as is usually the case, but rather with respect to the rate of return on capital. Thus the higher the rate of return on capital, the higher the marginal tax rate (see chapter 2 for a more in-depth discussion). Saskatchewan also levies a small gross royalty on the value of sales in the uranium industry and a per-unit "base payment" on production in the potash industry. All of these aspects make a straightforward application of the methodology outlined above somewhat difficult.

In this section, we briefly discuss they way in which these tax systems are modeled and present the relevant formulae. See Mintz (1985 a and b) for a more formal treatment.

i) Potash

In order to simplify the analysis and obtain formulae conducive to empirical evaluation, we convert the base payment into an *ad valorem* royalty on gross sales (see appendix B for an explanation of how this is done). Denote this royalty by g.

The graduated rate schedule is modeled as follows. A tax schedule graduated with respect to the rate of return on capital can be thought of as exempting a portion of the rate of return from tax where the amount of the exempted return depends on the capital investment base used to compute the rate of return on capital (this base is depreciated on a straight-line basis, at rate α_m, as discussed in chapter 2). Thus if the capital investment base is $\hat{B}_m$, then the taxpayer is allowed to deduct $\alpha_m \hat{B}_m$ for depreciation and $n\hat{B}_m$ for the exempt return, where n is the exempt rate of return.

Because the rate schedule is graduated, n varies with the mining tax rate u_m. For example, suppose the firm earned a rate of return in excess of 40 percent. Consulting the graduated rate schedule, this means that the capital cost deduction generated by the marginal expenditure is deducted at a rate of 50 percent (the top rate). However, the investment expands the capital investment base and increases the amount of income taxes at the lower rates. The first 40 cents of a dollar in returns generated by the new investment gives rise to tax revenue of 9.5 cents [(5x0) + (5x.1) + (10x.2) + (10x.3) + (10x.4) = 9.5; see chapter 2 for the rate schedule], for an average tax rate of 23.75 percent (9.4/40 = .2375). Allowing firms earning more than a 40 percent rate of return to exempt the first 21 percent, and taxing the excess at a 50 percent rate also yields 9.5 cents in tax revenue [(40-21)x.5 = 9.5] and an average tax rate on the first 40 percent rate of return of 23.75 percent. Thus, for the top rate bracket the exempt rate of return (n) is 21 percent.

Given this interpretation of the Saskatchewan potash tax regime (i.e., converting the per-unit base payment into an *ad valorem* gross royalty, and interpreting the graduated tax rate schedule as exempting a portion of the rate of return from taxation) we may proceed exactly as above by modifying the expression defining mining taxes as follows:

$$T_m = u_m [PQ - C(Q) - \alpha_m \hat{B}_m - n\hat{B}_m] + gPQ$$

This then yields the following user cost of capital expression for depletable capital:

$$MRP = \frac{(R + \delta - \pi)(1 - A_1 - A_2 - A_3)}{(1 - U - g/PCM)}$$

where PCM is the price cost margin, equal to $(P - C')/P$, and the present value of the mining tax deductions is determined by:

$$A_3 = u_m (1 - u_p) \frac{(\alpha_m + n)}{(\alpha_m + R)}$$

The only difference between this expression and the one derived above for the other mining tax regimes is the definition of the present value of the mining tax deductions, A_3, the inclusion of an additional term in the denominator, and the multiplication of the mining tax rate by $(1 - u_p)$. The first difference reflects the exempt rate of return as discussed above; the second, the imposition of a gross royalty which does not allow for the deduction of current costs; and the last, the deduction of the mining tax for provincial income tax purposes. Since the capital investment base is depreciated on a straight-line basis, the term for the present value of the mining tax deductions can be modified accordingly, as above.

The expression for exploration and development is exactly the same as that derived in section I, again with the above exceptions (because exploration and development are depreciated like physical assets, $B_3 = A_3$). The user cost expression for inventories is also the same.

The Hotelling rule for the depletion decision is slightly different due to the existence of the gross royalty:

$$\frac{(\dot{P} - \dot{C}')}{(P - C')} = \frac{R - \pi + g(1 - u_p)\,[\dot{P}/P + \dot{g}/g - (R - \pi)]}{PCM}$$

where $\dot{P}/P$ is the rate of growth in prices.

ii) Uranium

The taxation of uranium in Saskatchewan is similar to that of potash except for different rate of return brackets in the graduated tax schedule, the use of an explicit gross royalty, and the immediate expensing of expenditures on physical capital and exploration and development (see chapter 2).

The cost of capital expressions are thus identical to those discussed above for potash, with the exception that the present value of provincial mining tax deductions is now defined as follows:

$$A_3 = B_3 = u_m(1 - u_p)(1 + n/R)$$

where n is again the exempt rate of return.

The Hotelling Rule and the cost of capital expression for inventories are the same as those for potash.

Appendix B

DESCRIPTION OF THE DATA

In this appendix, we briefly describe the data used to estimate the cost of capital and effective tax rates that are measured according to the formulae presented in appendix A. A general description of the data requirements is also given in chapter 3.

1. Debt/Asset Ratio (β)

The debt/asset ratio is assumed to be 40 percent. This was determined by dividing total investment in the mining industry by new debt. The latter is defined as the difference between the year-end values of short-term and long-term loans, accounts payable and other current liabilities (including deferred income taxes). The source is aggregate data obtained from the Department of Finance.

2. Physical Rate of Depreciation (δ)

The service life of buildings in the mining industry is assumed to be 25 years, while for equipment a 20-year service life is assumed.

Based on these service lives, a declining-balance physical rate of depreciation is determined such that the time path of depreciation of the asset is approximately the same as the straight-line time path which would have fully depreciated the capital. Consider figure B.1, which depicts the capital remaining at various times under both exponential and straight line depreciation.

The area under the straight line is the total cost of the asset, T/2 (where T is the service life). The area under the exponential curve is $1/\delta$ (obtained by evaluating the integral $\int_0^\infty e^{-\delta t}dt$. We want to choose a δ such that these two areas are the same, or $1/\delta = T/2$. This means δ should be $2/T$. For buildings T is 25 and for equipment T is 20, yielding exponential rates of physical depreciation of 8 percent and 10 percent respectively.

3. Statutory Corporate Income Tax Rates (u_f and u_p)

The actual statutory federal and provincial income rates for large non-manufacturing businesses are used. The pre-reform federal income tax rate is 36 percent and the post-reform rate is 28 percent.

The provincial income tax rates assumed for large non-manufacturing businesses in 1987 are:

Province	*Rate (percent)*
Ontario	14.5
Quebec	5.5
British Columbia	16
Newfoundland	16
New Brunswick	15
Manitoba	16
Nova Scotia	15
Alberta	11
Saskatchewan	14

4. The Rate of Inflation (π)

An expected rate of inflation of 5 percent is assumed. This is based upon an average of forecasts by various forecasting agencies.

5. Nominal Interest Rate on Debt (i)

The nominal (risk-free) interest rate on debt is assumed to be 10 per cent.

6. Capital Cost Allowance (CCA) Rate (α)

An average CCA rate is used for the α in the formulas presented in appendix A and chapter 3. A weighted average is computed by using Department of Finance data on CCA additions for each class. As discussed in chapter 2, the most important CCA classes in the mining industry are classes 3, 10, 28, 29 and 12.

Appropriate adjustments are made to the rates to reflect the tax reform proposals (see chapter 2).

7. Investment Tax Credit (ITC) (ϕ)

Average ITC rates for each CCA class are determined using Department of Finance data. ITC earned for each class is divided by CCA additions to determine the average "effective" ITC rate for each class. Then, an overall weighted-average ITC rate is determined using the same weights used to compute the average CCA rate (see above).

Tax reform largely eliminates the ITC except for specific geographical areas. The post-reform figures are adjusted to reflect this change by eliminating the ITC for all provinces except the Maritime provinces.

8. The Nominal Cost of Equity Finance (ρ)

Given the open economy assumption, capital market equilibrium requires that the after-tax rate of return to a U.S. investor (assumed to be the "marginal" investor) on equity must be equal to the after-tax rate of return on debt, or $(1 - c_u)\rho = (1 - m_u)\, i$, where c_u and m_u are the U.S. tax rates on debt and equity respectively. Given these tax rates and the market nominal rate of interest, the cost of equity is then $\rho = i(1 - m_u) / (1 - c_u)$.

"Reasonable" values for c_u and m_u are assumed to be .25 and .3 respectively. Given a nominal rate of interest on debt of 10 per cent, this implies a nominal risk-free required rate of return on equity of 9.03 percent.

9. The Risk Premium (h)

It is very difficult to obtain required risk premium estimates for different types of risk on different types of expenditures. For income risk, this poses no problems since we defined the gross rate of return net-of-risk, and the income risk premium enters the expression additively (see chapter 3). For capital risk on depreciable assets, the problem is more acute as the risk premium enters the gross rate of return expression multiplicatively.

In order to illustrate the important effect that capital risk can have on effective tax rates, we assume a somewhat arbitrary risk premium of 4.3 percent. This roughly corresponds to a 6 percent Capital Asset Pricing Model estimate of the risk premium on equity required in the mining industry [see Parker (1984)]. The 4.3 percent is obtained by "unlevering" the risk premium on equity by dividing is by (1 - .4), where .4 is the debt/asset ratio, and assuming that debt is essentially riskless.

10. The Loss Refundability Parameter (ξ)

In the empirical estimates, we use the average refundability parameter described in chapter 3 (following Mintz (1988):

$$\xi = \lambda + \frac{(1-\lambda)}{TR}\left(1 - \frac{1}{(1+R)}\right)^{T}$$

where T is the period it takes to write off all tax losses and unused deductions, λ is the proportion of losses carried back for immediate refund, and R the after-tax weighted-average cost of finance.

From Mintz (1988), the value of ξ for the resource sector is estimated to be .24 on average.

11. Expected Corporate Tax Loss Per Dollar of Expenditure (μ)

This parameter is used to estimate the gross rate of return for the start-up firm in the imperfect loss offset case. It is calculated as follows:

$$\mu = \frac{\text{Reported Tax Losses}}{\text{Capital Stock}} + \frac{\text{Present Value of Additional Unused Tax Deductions}}{\text{Capital Expenditures}}$$

Using data obtained from the Department of Finance, this was calculated to be .1638 for the mining industry.

12. The Tax Rate on Dividends (θ)

In our analysis of the impact of different financing options on effective tax rates, we require a personal tax rate on dividends for the flow-through share and new share issue cases. The tax rate on dividends is determined by the following formula, which incorporates the gross-up and credit system used for the taxation of dividends in Canada:

$$\theta = [(1 + G)m] - C$$

where

m = the combined federal/provincial income tax rate (see below)

G = the gross-up rate for dividends

C = the combined federal/provincial dividend tax credit rate

The pre-reform value for G is 1/3 while the post-reform value is 1/4. The pre-reform value for C was approximately .329 for an Ontario resident, while the post-reform value is approximately .247. For m, the top-bracket rate for an Ontario taxpayer is assumed, which was .5032 prior to reform, and .4292 after reform. The $1000 tax-free investment income exemption is ignored. Thus the pre-reform tax rate on dividends is approximately 34.2 percent while the post-reform rate is 28.95 percent.

13. The Accrued Capital Gains Tax Rate (c)

In our analysis of different financing options we also require a figure for the effective capital gains tax rate on an *accruals* basis. This is not a simple matter, as capital gains in Canada are in fact taxed on a realized basis rather than as they accrue. It is thus necessary to convert the statutory realized rate into an accruals rate.

The accrued capital gains rate is determined in accordance with a method suggested by Boadway, Bruce and Mintz (1981). The idea is to compute a tax

rate on accrued capital gains so that the present value of capital gains on a realized basis is equal to the present value of taxes levied on accrued capital gains.

Consider an individual who invests $1 in an equity share, the price of which grows at a nominal rate of g per year. After a holding period of T years, a capital gains tax of c_r is levied on the realized capital gain of $e^{gT} - 1$. If we let $\rho + h$ denote the risk-adjusted discount rate of the shareholder, then the present value of wealth at time t=0 when capital gains are taxed on a realized basis is:

$$W_r = e^{gY} e^{-(\rho + h)T} - c_r (e^{gT} - 1) e^{-(\rho + h)T}.$$

We now determine the present value of wealth if capital gains are taxed on an accruals basis at rate c. Each year the capital gain is ge^{gt}, the present value of wealth with an accrued capital gains tax is then:

$$W_a = e^{gT} e^{-(\rho + h)} - c \int_0^T e^{gT} e^{-(\rho + h)t} dt$$

Let $W_a = W_r$ and solve for c:

$$c = \frac{c_r (e^{[g - (\rho + h)]T} - e^{-(\rho + h)T}) [(\rho + h) - g]}{g(1 - e^{[g - (\rho + h)]T})}$$

The following values were used for the calculations:

c_r = .32 (post-reform), .25 (pre-reform)

g = .05 (the continuous time average growth rate in the TSE from 1976 to 1984)

$\rho+h$ = .15 (see risk premium and cost of equity above)

T = 10 (average holding period of equity - see Boadway, Bruce and Mintz (1981)

The realized capital gains rate, c_r, is determined by multiplying the top-bracket personal tax rate by 50 percent in the pre-reform case and 75 percent in the post-reform case (reflecting the capital gains inclusion rates). See point 12 above for the top-bracket personal tax rates. Given these parameter values, the effective accrual capital gains tax rate is 12 percent for the pre-reform system and 15 percent post-reform. In the calculations presented in chapter 3, we use these rates as well as an assumed 0 percent capital gains rate, reflecting the existence of the capital gains exemption, which is particularly important for flow-through shares.

14. Other Parameters

a) Federal and Provincial Income Tax parameters:

Resource Allowance (σ) = .25
Federal Earned Depletion Rate (d) = 1/3 (0 post-reform)
Federal CDE Rate (α_d) = .30
Ontario Automatic Depletion Rate (γ) = 1/3
Federal Inventory Allowance Rate (v) = .03 (0 post-reform)

b) Provincial Mining Tax Parameters

Province	*Basic Mining Tax Rate (u_m)*	*Maximum Process Allowance (ψ)*	*Depreciation Rate Mining (α_m)*	*Depletion rate (d_m)*
Ont.	20	65	30 sl[1]	N/A
Que.	18	65	30 sl	33
B.C.	17.5	70	Fed CCA	33
Nfld.	16[2]	65	10 db	N/A
N.B.	16	65	33 db	50
Man.	18	65	20 db	N/A
N.S.	15[3]	65	30 db[4]	N/A

1. A 100 percent deduction is allowed for new mine assets up to the income from the mine. The rate for processing assets is 15 percent straight line.

2. 15 percent of the first 80 percent of income, 20 percent on the remainder.

3. Mining taxes are actually the greater of 2 percent of net smelter income or 15 percent of net revenue from the mine. We assume the latter.

4. 100 percent in the first three years of operation up to the income from the mine and 30 percent thereafter.

Newfoundland resource allowance (σ_m) = .25

New Brunswick financing allowance (x) = .08

New Brunswick net royalty rate (u_{m2}) = .02

New Brunswick processing allowance maximum on net royalties (σm) = .2

c) Saskatchewan potash and uranium tax parameters

The statutory gross royalty rate on Saskatchewan uranium (g) is 3 percent. To convert the per-unit base payment on potash to an *ad valorem* gross royalty rate, we follow Mintz (1986a) and divide total revenues from the base payment by gross revenues. Using data obtained from the Saskatchewan government, Mintz computes an average royalty rate of 8 percent for potash.

The exempted rate of return (n) depends upon the marginal tax rate (u_m) of the taxpayer. For simplicity, we present figures for a firm in the 30 percent tax bracket for potash, and 50 percent for uranium. Again using figures derived by Mintz (1985 a and b), these brackets imply an exempt rate of return of 11.67 percent for potash and 31.5 percent for uranium.

The average nominal expected ore price increase (P/P) for both potash and uranium was assumed to be 5 percent, implying a 0 percent real increase.

Mintz (1985 a and b) reports effective tax rates for a number of price-cost margins (PCM). He bases his estimates on total cost and revenue data provided by the Saskatchewan government. The illustrative figures contained in chapter 4 are based upon price-cost margins for the uranium and potash industries of .5 and .46 respectively.

Appendix C

NOTATION

r_g	gross of tax marginal return
MRP	marginal revenue product
r	weighted average marginal cost of funds
R	after-tax weighted average marginal cost of funds
π	expected rate of inflation
δ	economic rate of depreciation
P	price of a unit of output
C	marginal current cost of a unit of output
MP_k	marginal product of capital
q	price of a unit capital
β	proportion of investment financed by debt
i	nominal interest rate on debt (risk-free)
ρ	nominal required return to equity (risk-free)
W	marginal cost of a unit of exploration and development
A	$A_1 + A_2 + A_3$
A_1	present value of federal income tax deductions on a $1 expenditure on depreciable capital
A_2	present value of provincial income tax deductions on a $1 expenditure on depreciable capital
A_3	present value of provincial income tax deductions on a $1 expenditure on depreciable capital
B	$B_1 + B_2 + B_3$
B_1	present value of federal income tax deductions on a $1 expenditure on exploration and development
B_2	present value of provincial income tax deductions on a $1 expenditure on exploration and development.
B_3	present value of provincial mining tax deductions on a $1 expenditure on exploration and development
u_f	statutory federal corporate income tax rate
u_p	statutory provincial corporate income tax rate
u_m	statutory provincial mining tax rate
U	$U_f + U_p + U_m$
U_f	effective statutory federal tax rate

U_p	effective statutory provincial tax rate (varies among provinces)
U_m	effective mining tax rate (varies among provinces)
σ	federal allowance rate
φ	federal ITC rate
Z_f	present value of federal CCA deductions
Z_p	present value of provincial CCA deductions
Z_m	present value of mining tax depreciation deductions
ψ	mining tax processing allowance ceiling
d	federal earned depletion rate
v	inventory allowance
t_c	effective tax rate
h_i	income risk premium
h_k	capital risk premium
ξ	refundability parameter
λ	proportion of less carried back
x	price of a flow-through share
C	annual capital gains tax rate
M	personal tax rate
θ	tax rate on dividends
T_c	corporate income tax (federal and provincial)
T_m	provincial mining tax
CF	cash flow
Q	output
I	gross investment in physical capital
X	expenditures on exploration and development
RA	resource allowance
DA	depletion allowance
B_m	undepreciated cost of capital for mining tax depreciation purposes
B	undepreciated cost of capital for income tax depreciation purposes
S	stock of the raw reserves
F(S, K)	depletable reserves production function
K	depreciable capital
G(X)	raw reserves production function
κ	real flow value of tax depreciation allowances
α_f	federal/provincial CCA rate
α_m	mining tax depreciation rate

$\hat{\delta}$	exported economic rate of depreciation
s	state of nature
g(s)	density function over
u(s)	state contingent corporate tax rate
σ_m	mining tax resource allowance
Z_d	present value of CDE deductions
γ	Ontario automatic resource allowance rate
U_{ma}	New Brunswick net royalty rate
d_p	earned depletion rate for provincial mining tax purposes
g	royalty rate on gross sales (Saskatchwan potash tax)
n	excerpt rate of return (Saskatchewan potash and uranium tax)
α_d	federal CDE rate

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